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OVERHEAD WIRES.

THE recent decision of Mr. Justice Stephen in the case of the Wandsworth Board of Works is probably the first important step towards a definite settlement of the future fate of overhead wires; pending the appeal which it is intended to make it is difficult to say what the actual result of the proceedings which have been taken will be. Even if the result be to put it in the power of the Vestry authorities to absolutely forbid the erection of overhead wires we very much doubt whether such power would be exercised, seeing the important interests which are involved in the question. To force the telephone companies to place all their wires underground would be a most serious matter; in fact, it would imperil the very existence of the companies in consequence of the heavy expense which it would involve, not only on account of the lines themselves, but from the necessity which would arise of providing instruments which would be capable of working efficiently through underground wires. The commercial public, who are greatly interested in the question, would hardly look with equanimity on the raising of the already high annual rentals which they have to pay for the convenience of telephone communication, but unless they submit to pay increased rentals they would probably have to cease to have the advantages which the telephone confers, in the event of the wires having to be placed underground.

The character of the Vestries is well known: their policy is rarely that of anything but obstruction; in the present case the latter is, we think, utterly absurd and unjustifiable; if the dangers of overhead wires were palpably real there might be some justification for the outcry raised, but facts most clearly show that the dangers do not exist. Of course a wire gradually deteriorates in time, but the prevention of its breakage is as much to the interest of the owners of the wires as to the general public. A certain amount of risk, of course, exists, and to minimise this as much as possible is naturally desirable, but this would, we think, be best done by a periodical inspection conducted by the Board of Trade authorities.

The Vestries have, we think, plenty of matters nearer home, and of infinitely greater importance to the welfare of the community, which require attention, than the imaginary dangers of overhead wires, but they seem to prefer to provide for contingencies which practice has amply proved are very unlikely to occur, quite regardless of the excessive inconvenience which may be caused by their action.

Personal.—We understand that Mr. Henry C. Grahame, late superintendent in Devon and Cornwall to the United Telephone Company, has been appointed manager to the Electric Apparatus Company.

APPARENT RESISTANCE OF THE VOLTAIC ARC IN LIGHTHOUSES.

By M. F. LUCAS.

THE ordinary voltaic arc of lighthouses (*simple light*) plays between the points of two Carré's carbons, of 16 millimetres in diameter, and kept at an approximately constant distance from each other (four millimetres average) by the action of a Serrin regulator. The introduction of a voltaic arc into a circuit supplied by a magneto-electric machine with alternating currents produces always a decrease in the mean intensity of the current. Effects take place as if the arc itself was a conductor, whose resistance, ζ, would be a function of two variables: the intensity, I, of the electric current, and the distance, ε, of the points of the carbons. We may therefore put

$$(1) \qquad \zeta = \phi(I)\,\psi(\varepsilon)$$

ϕ and ψ being two unknown functions which it is necessary to determine.

In order to study the function $\phi(I)$, we must ascribe to ε a constant value and let I vary. To realise experiments of this nature, that is, to preserve ε at an almost invariable value in spite of the variations of the current, it would be difficult to give the voltaic arc an appreciable length. It is easy, on the other hand, to render ε almost null by keeping the two circular bases of the carbons in contact. In this manner $\psi(\varepsilon)$ becomes $\psi(o)$ and assumes a constant value which may be represented by unity. I bring then in contact by their points, two Carré pencils, of 16 millimetres in diameter and of 0·40 metre in length, between their bronze sockets. The resistance, when cold, of this system (not including the increased resistance resulting from the break of continuity at the contact of the points) had the value of 0·135 ohm. If a current passes of the intensity I, the proper resistance, η, of the two pencils is given by the formula

$$(2) \qquad \eta = 0{\cdot}135 \text{ ohm} \left(1 - \frac{1}{25 \text{ amp.} + 1{\cdot}2\,I}\right)$$

which I have formerly established and indicated in the *Comptes Rendus* of March 31st last. Adopting for the magneto-electric machine a fixed mode of coupling (both circuits in tension), I cause the intensity of the electric current to vary by modifying, on the one hand, the number, n, of the revolutions which the armature makes per minute, and on the other part, the length of the copper conductors (of the resistance of 0·000464 ohm per metre run), which I interpose in the external circuit. For each value of I, measured by means of an electro-dynamometer, the total resistance, R, of the outer circuit is given by the formula

$$(3) \qquad R = \frac{12{\cdot}88 \text{ volts} + 0{\cdot}218 \text{ volt } n}{I} - 0{\cdot}254 \text{ ohm} - 0{\cdot}00254 \text{ ohm } n.$$

the origin of which I have made known in the *Comptes Rendus* of March 17th. By deducing from R, on the one hand, the resistance, η, of the carbons, and on the other the known resistance of the copper conductors, I obtain, for each value of I, the resistance $\phi(I)$ corresponding to a voltaic arc of a length almost null, playing between the points of the two carbons. In these experiments the intensity, I, has varied from 40 to 75 ampères, and I have found that the results obtained are represented with a close approximation by the empirical formula

$$(4) \qquad \phi(I) = 0{\cdot}40 \text{ ohm} \left(1 - \frac{1}{80 \text{ amp.}}\right)$$

The formula (1) becomes consequently

$$(5) \qquad \zeta = 0{\cdot}40 \text{ ohm} \left(1 - \frac{1}{80 \text{ amp.}}\right)\psi(\varepsilon).$$

It only remains to determine the nature of the function, ψ, of the distance of the carbons, for which purpose I have made another series of experiments. The resistance, when cold, of the system of two carbons employed (of 16 millimetres in diameter)

was in these new experiments 0·094 ohm. There were interposed in the circuit 49 metres of copper cable, presenting a resistance of 0·023 ohm. The speed of rotation of the inductor remained constant in all the experiments ($n = 430$ revolutions per minute). The intensity, I, of the current under these conditions became a function of the mutual distance, ε, of the points of the carbons. At a distance apparently null, I obtained 74·36 ampères; at 4 mm. distance it was 58·17; at 9 mm. the intensity fell to 34·30 amp., and at 10 mm. the arc was extinguished and the current ceased to pass. The results of the experiments may be expressed by the empirical formula

$$(6) \qquad I = 75 \text{ amp.} \left(1 - \frac{\varepsilon}{16{\cdot}67 \text{ mm.}}\right)$$

in which ε may vary from 0 to 9 mm.

For each value of I the total resistance, R, of the outer circuit is given by the formula

$$(7) \qquad R = \frac{106{\cdot}58 \text{ volts}}{I} - 1{\cdot}346 \text{ ohm.}$$

On deducting from R the resistance of the copper cables as well as that of the carbons, we have

$$(8) \quad \zeta = \frac{106{\cdot}58 \text{ volts}}{I} - \frac{0{\cdot}0941 \text{ ohm}}{25 \text{ amp.} + 1{\cdot}2\, I} - 1{\cdot}463 \text{ ohm}$$

for the value of the actual resistance of the voltaic arc.

Let us now consider the formulæ (5), (6), and (8). On giving to ε a value intermediate between 0 and 9, I obtain I by the formula (6). On inserting this value of I into the formula (8), I obtain ζ; by replacing I and ζ by their values in the formula (5), I calculate $\psi(\varepsilon)$. We may thus deduce from the experiments the values of $\psi(\varepsilon)$, which correspond to different values of the variable ε. The results thus obtained have led me to the empirical formula

$$(9) \qquad \psi(\varepsilon) = 1 + \frac{\varepsilon}{1{\cdot}4 \text{ mm.}}$$

Thus, ultimately, the resistance, ζ, of the voltaic arc may be represented by the formula

$$(10) \quad \zeta = 0{\cdot}40 \text{ ohm} \left(1 - \frac{1}{80 \text{ amp.}}\right)\left(1 + \frac{\varepsilon}{1{\cdot}4 \text{ mm.}}\right)$$

At an intensity of 50 ampéres and a distance of 0·004 metre between the points of the Carré pencils, the normal conditions of the production of the voltaic arc in our lighthouses, the resistance of the arc is 0·58 ohm.

ON THE ABSOLUTE STANDARD OF LIGHT.

By M. J. VIOLLE.

THE study of the radiation emitted by melted silver had essentially for its object the verification of the principle of the method which consists in taking as standard the light of a metal at its point of fusion, following the idea which I put forward at the International Congress of Electricians in 1881.

Preliminary researches having shown the constancy of the radiation during the whole time of solidification, I was enabled to take in hand with safety the realisation of the absolute standard.

I take, as an absolute unit of light, the radiation emitted by a surface of one square centimetre of platinum at its point of solidification.

To obtain any given multiple of the unit it is merely requisite to increase the surface.

The Carcel lamp, of Dumas and Regnault's model, having being adopted as a usual secondary standard I have been obliged, in the first place, to determine the value of this lamp in relation to my type-standard. By means of different methods, which gave accordant results, I found for the value of the normal Carcel lamp, C,

$$C = \frac{1}{2{\cdot}08};$$

whence, taking the surfaces into account, it may be concluded that the intrinsic intensity of our standard is, approximately, eleven times that of the Carcel lamp.

I have also operated upon electric foci. The comparison with the standard has been found practically very satisfactory. I describe merely the experiments made with incandescence lamps, the colour and the constancy of which render the comparison with platinum very easy and certain.

The incandescence lamp (Swan's system) was supplied by a battery of 30 Kabath's accumulators. A resistance-box inserted in the circuit enabled us to vary the arrangement. Every minute an observer noted the intensity, i, of the current, and the decline of the potential within the limits of the lamp. It was, therefore, merely requisite to take the instant of each photometric measurement in order to know the corresponding condition of the lamp, and consequently its lighting-power; special experiments at the beginning and at the end of each series of observations having determined this power for different values of i, E. The relative values of E given below, being deduced from electric measurements, are independent of the possible variations of the Carcel lamp.

In order to compare the electric lamp with the standard I made use of a Bunsen's photometer, which could be moved between the two sources of light which were separated from each other by a distance of four metres. The rays emitted vertically by the platinum were thrown horizontally by means of a mirror at 45°, the total effective distance being about 4·50 metres. It was accurately determined each time. We call it Δ, and the distance from the platinum to the photometer D.

At the first sitting three different observers took each six measurements. From the eighteen determinations thus obtained, we may deduce as many values of the expression $\frac{E\,D^2}{(\Delta - D)^2}$ representing the intensity, in Carcels, of the light reflected by the mirror placed above the platinum. As for the observers, these values are divided in three groups, of which the respective means are:—

G	...	...	...	7·018
M	...	...	...	7·016
V	...	...	...	7·035
	Mean		...	7·023

As for the arrangement of the lamp, they are also divided into three groups.

i	e	$i \times e$	E	D	$\frac{D^2}{(\Delta - D)^2}$	$\frac{E\,D^2}{(\Delta - D)^2}$
0·88	48·2	42·4	1·64	3060	4·275	7·011 (7 exp.)
0·88	48·5	42·7	1·75	3033	4·067	7·066 (3 „)
0·88	48·4	42·6	1·71	3040	4·108	7·023 (8 „)
					Mean ...	7·023

At a subsequent sitting the arrangement of the lamps was made to vary much more. The subjoined table summarises the observations.

i	e	$i \times e$	E	D	$\frac{D^2}{(\Delta - D)^2}$	$\frac{E\,D^2}{(\Delta - D)^2}$
0·86	47·7	41·0	1·35	3140	5·177	6·989 (3 exp.)
0·86	47·9	41·2	1·37	3130	5·071	6·947 (2 „)
0·86	48·0	41·3	1·38	3130	5·071	6·998 (2 „)
0·89	49·3	43·9	1·70	3030	4·135	7·029 (3 „)
0·89	49·5	44·6	1·80	2995	3·857	6·943 (2 „)
					Mean ...	6·986

The photometric measurements agree well with the electric measures. They give for the normal Carcel, $C = \frac{1}{2{\cdot}07}$, a value very near that which we have found directly.

To sum up, platinum at its melting point fulfils the conditions which we must require from an absolute standard of light: it depends on a physical phenomenon perfectly definite and constant, and being of a convenient magnitude it yields a practical term of comparison for the customary standards.—*Comptes Rendus.*

THE EDWARDS DYNAMO-ELECTRIC MACHINE.

THE Edwards armature is an open-circuit one, and its main peculiarity is in its manner of commutating the currents which are generated in the coils or bobbins of its armature during operation. Therefore it can be made in a number of ways, resembling the Gramme, Siemens, Weston and Brush armatures, except that in all cases the bobbins must be open-circuited to a commutator instead of to a collector, for the reasons herein set forth.

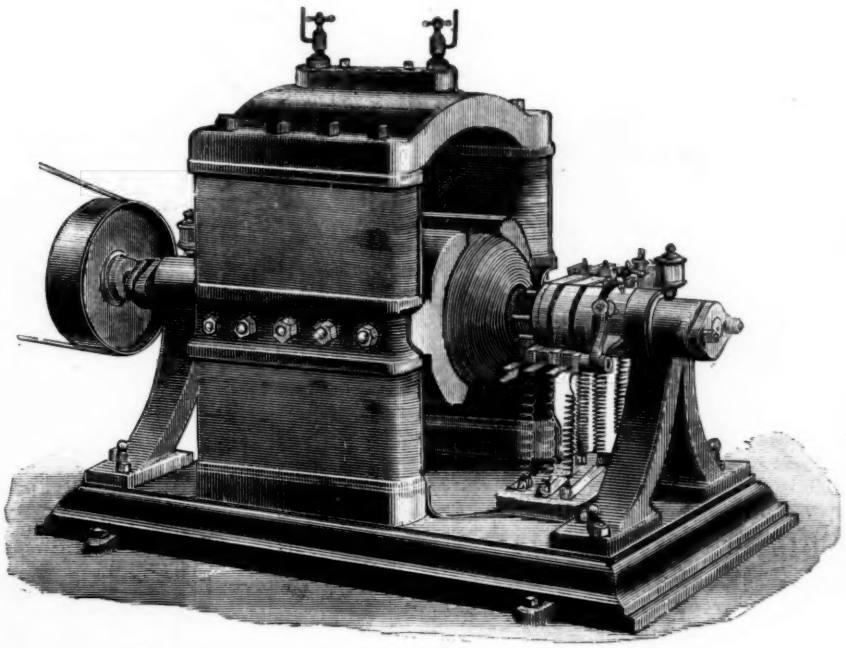


FIG. 1.

The Edwards dynamo-electric machine is the invention and design of Mr, Edgar A. Edwards, of Cincinnati, Ohio, and is manufactured by the Commercial Electric Company, of Dayton, Ohio. We have recently seen, states the New York *Electrical World*, one of these machines in operation in Thirteenth Street in this city, running 21 arc lamps on a circuit having about 11 ohms resistance other than the resistance of the lamps, and we deem the result of the tests there made to be of interesting value to our readers. Therefore we proceed to describe and illustrate that machine and point out its peculiarities.

Fig. 1 is a perspective view of the machine. Upon a cast-iron base two magnet cores of cast-iron are erected and are capped as shown by the arched cast-iron piece to complete the magnetic circuit. The base is reinforced with iron underneath, between the two cores, so as to make a sufficient mass of metal. To the centres of these two vertical cores are bolted the pole pieces, facing each other, which constitute the consequent poles of the field-magnets. Four bobbins of No. 8, B. & S. gauge magnet wire are wound upon these cores, and are connected up in series, so that by means of currents which are caused to circulate in them, one pole piece has north polarity conferred upon it, and the other has south polarity.

Two standards, carrying boxes for the shaft of the armature, are likewise erected upon the base. These boxes are made to fit tapering journals on the armature shaft, so that by means of suitable caps and set screws (one of which caps is shown at the box on the foremost standard) the boxes may be moved towards each other: that is, further on to the tapering journals of the shaft, to compensate for wear of the journals and boxes. Thus far the machine does not differ in electrical particulars from others of its class except in design and workmanship.

The armature consists of a core and three bobbins, which are made of 85 lbs. of No. 12 B. & S. gauge, double covered magnet wire, and the two ends of each bobbin are carried to two halves of a commutator belonging to that bobbin; so that there are three commutators. These commutators are fastened to the shaft so that their break-lines are 120° from each other, or so that one of the two breaks in each commutator follows the preceding one in coming under the brush in each 60° of a rotation. The brushes are connected up in series with each other and with the field-magnet coils and the external circuit.

Fig. 2 represents a cross-section of the armature, and a description of the figure will convey a good idea of its construction. X is the shaft, and fastened to it is the wooden hub, B. The wooden hub extends nearly the length of the armature, and has six semi-cylindrical grooves, N, made in it, to act as air channels in ventilation, and to receive the bases of the sheet-iron clamps, *d*. D represents a flat ring made by winding between the arms of the six clamps, *d*, a ring of No. 25 iron wire. This ring is one inch deep and $\frac{3}{16}$ths inch thick, and weighs ·74 lb. There are 62 of these rings placed on the wooden hub, side by side, but insulated from one another. They weigh 46 lbs. altogether. The clamps, *d*, keep them slightly apart, so that air which is drawn into the grooves during rotation escapes through the spaces between the rings, and thus serves to conduct off the heat which would otherwise accumulate.

The ends of the clamps project as shown, and are pierced with holes, E. When a lot of the rings are in place these holes receive six tie rods, which pass

through them and through similar holes of two solid half-round rings, one at each end of the core. These solid rings are screwed to the wood to bind the whole together in one solid mass. The six spaces between the ends of the clamps are of equal area, and receive the bobbins of insulated wire, the sections of which are shown in the figure. This construction of the core so separates and insulates the iron of the ring, that Foucault currents are very much reduced, and their ill-effects almost entirely obviated.

The coils of wire constituting the bobbins are wound in greater part parallel with the shaft, but cross diametrically from side to side as with the Siemens armature winding. The ends are, however, left free to be connected to the commutators. The commutators are of peculiar construction and special to this machine. They are best illustrated by the parts, separate and assembled, shown by fig. 3. This figure shows four commutators, such as are intended for four bobbins. Those for three bobbins differ only in number. A description of one answers for the whole, as they are all alike.

Upon the shaft is placed a disc, *h*, of insulating material, and upon the periphery of this disc two semi-annular metal pieces, *i* and *j*, are suitably fastened.

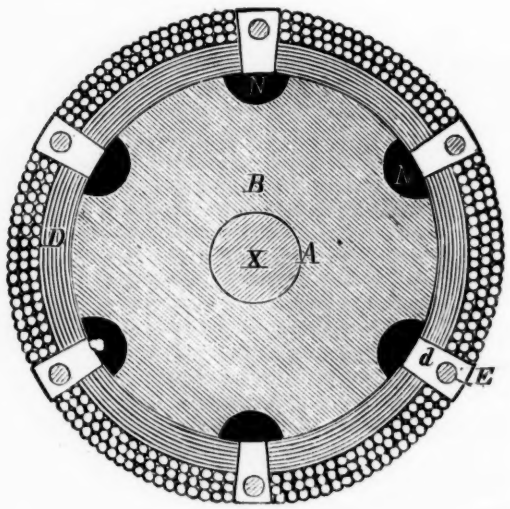


FIG. 2.

A small space is left between the ends so that they are electrically insulated from each other. Each piece has two rectangular portions removed from it, one from each end, but from opposite sides of the piece. A piece of metal, K, also passes over the shaft, but out of contact with it, and it has two lugs, *l*, *l*, at right angles to its plane. These lugs nearly fill the spaces formed by the removed parts of the commutator pieces, but they are insulated from the pieces.

Now, when the brushes bear upon the commutator at the breaks between the pieces, they also bear upon the piece of metal, K. This is also the case for some distance in the rotation of the commutator before the breaks reach the brushes and after passing them. During this time of bearing of the brushes on piece K, in this way, the bobbin connected with the two pieces, *i* and *j*, is short-circuited upon itself. This time or space of short-circuit is that in which the bobbin is passing the line of magnetic neutrality midway between the poles. In this feature resides the special excellence of the Edwards system of commutating the currents generated in the armature.

In the machine we are describing three such commutators are fastened on the shaft, at suitable distances apart, and with their breaks 60° apart circumferentially. The electrical connections between the ends of the wires of the bobbins and their respective commutator divisions or pieces, are made by means of conducting rods which pass to the insulating discs of the three commutators, and through the ones between each and the armature. Suitable connections of the bobbin wires and of the commutator pieces are made to the conducting rods.

There are as many pairs of brushes as there are commutators. The positive brushes are held by one brush holder, and the same is the case with the negative brushes. But each brush is separately insulated from its holder. The brushes are electrically connected together, so that the current generated in one bobbin passes to its positive brush, and from there to the negative brush of the next bobbin, through that bobbin, receiving its additional energy, to its positive brush; and so on through the several bobbins to the external circuit, and the field-magnets, as in other series machines, with this exception:—As the edge of a bobbin reaches the neutral line, so does its short-circuiting piece, K, reach and pass under the appropriate pair of brushes, thus short-circuiting that bobbin

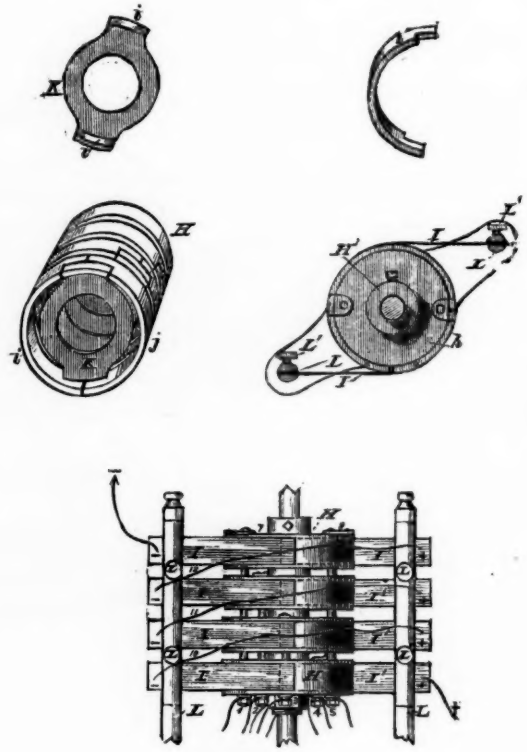


FIG. 3.

by a conductor of comparatively no resistance. This condition is diagramatically represented by fig. 4, in which *e*, *e'*, *e''* represent the three bobbins, and I, I the connection of the commutator with the brushes, and K the short circuit. It is plain, then, that nearly all of the current from the two other bobbins will flow through K instead of through *e'*, where it would receive no addition of strength or electromotive force.

This described action is repeated with each successive bobbin as it passes through the neutral zone. The bobbins are never passed out of circuit, as in other machines, but are merely bridged at proper intervals, to allow of the passage of currents which would otherwise receive no assistance there, but would lose the proportion of their energy due to the resistance they would encounter. Thus much of the sparking between commutator and brushes, which is so observable and objectionable in other open-circuit machines, is avoided with a corresponding increase in efficiency, and decrease in cost and frequency of repairs.

The machine runs quietly, and during the half hour in which we observed its operation the possible rise in

temperature of the armature was not appreciable, though 23 lamps were in its circuit. We do not think that such an arrangement of bobbins, &c., gives a continuous current of constant strength, but rather one which is pulsating—rising and falling in electromotive force and intensity. However, this does not seem to be objectionable in arc-lighting, provided the pulsations are sufficiently rapid to prevent them being exhibited in the light to the eye. It fact it has been urged that such a current gives greater light effects for a given expenditure of power. The success of the Brush and of the

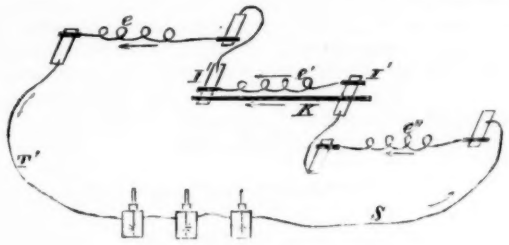


FIG. 4.

Thomson-Houston machines, which are of the open-circuit pulsating current class, points to that conclusion. Indeed, until we find the at present unknown dynamic value of light, and settle upon a more nearly perfect system of light measurement, the actual facts in these cases will remain unsettled and in dispute.

We have had handed to us a set of measurements made of this machine. They are tabulated below :—

Weight of machine, with base	2,250 pounds.
„ „ armature with shaft	210 „
„ „ wire on field-magnets	285 „
„ „ „ armature	85 „
„ „ core of „	46 „
Size of wire on field-magnets	No. 8 B. & S.
„ „ armature	„ 12 „
Diameter of field	11 inches.
Length „ „	17 „
Total resistance of machine	8·6 ohms.
Resistance of line	11 „
External resistance, including 23 lamps ...	92·03 „
Resistance of lamps	81·03 „
Differences of potentials at binding-posts ...	805·26 volts.
Intensity of current	8·75 ampères.
No. of rotations per minute	1,240
Power applied to engine, machine and belting ...	15·985 H.P.
„ absorbed in friction, by indicator card, no load	3·197 „
„ absorbed by engine	1·728 „
Probable power absorbed in friction with the full load	0·799
Power applied to production of electricity ...	11·989
Energy of current in external circuit $C \times E = 8{\cdot}75 \times 805{\cdot}26 = \frac{7{,}046}{746} =$	9·445 „
Energy of current in internal circuit $C^2 \times R = 8{\cdot}75^2 \times 8{\cdot}6 = \frac{658{\cdot}43}{746} =$	0·882 „
Electrical energy in entire circuit	10·327 „
Percentage of electrical return $\frac{10{\cdot}328}{11{\cdot}989} =$	86 per cent.
Percentage of electrical return in external circuit	91 „ „

The low resistance of the machine is specially noticeable.

ON THE MOST ECONOMICAL SIZE OF ELECTRICAL CONDUCTORS.

THE problem of determining the most economical size of a conductor designed to transmit electrical energy for lighting or as a source of power, is one of great importance and not difficult of solution.

Let E represent the difference of potential between the terminals of the main conductor at the dynamo, R the resistance of the conductor, r the combined resistance of the lamps, and C the total current ; then by Ohm's law

$$E = C\,(R + r)$$

If H.P. represent the energy of the current measured in horse-power, then

$$\text{H.P.} = \frac{C\,E}{745} = \frac{C^2\,(R + r)}{745}$$

The resistance is here composed of two parts ; and since the heating effect of the current, or the loss of electrical energy, in various parts of the circuit varies directly with the resistance, the horse-power wasted upon the conductor is evidently expressed by the equation—

$$\text{H.P.} = \frac{C^2\,R}{745} \qquad (1)$$

Let p be the cost of an electrical horse-power transmitted to the conductor for one hour, and n the number of hours in a year that the current is used ; then the cost of the current wasted in the conductor during the year will be

$$\text{Loss per year} = p\,n\,\text{H.P.}$$

Substituting value of H.P. in (1)

$$\text{Loss per year} = \frac{p\,n\,C^2\,R}{745} \qquad (2)$$

Let R^{sp} be the specific resistance (the resistance of unit length of unit cross section) of the material composing the conductor, l its length, and d its diameter if round ; then the area of cross section of the conductor will be expressed by

$$\square = \pi \left(\frac{d}{2}\right)^2 = \frac{\pi\,d^2}{4}$$

The total resistance of the conductor will be

$$R = \frac{R^{sp}\,l}{\frac{\pi\,d^2}{4}} = \frac{4\,l\,R^{sp}}{\pi\,d^2} \qquad (3)$$

Substituting this value in (2) we have

$$\text{Loss per year} = \frac{p\,n\,C^2\,4\,l\,R^{sp}}{745\,\pi\,d^2} \qquad (4)$$

Let W represent the weight of unit length of unit cross section of the conductor ; then

$$\text{Weight of conductor} = \frac{W\,L\,\pi\,d^2}{4} \qquad (5)$$

If the cost of unit weight, *in situ*, be g, then

$$\text{Cost of conductor} = \frac{g\,W\,l\,\pi\,d^2}{4} \qquad (6)$$

Let i be the current rate of interest, then

$$\text{Interest on cost of conductor} = \frac{i\,g\,W\,l\,\pi\,d^2}{4} \qquad (7)$$

Now the cost of the conductor, and consequently the interest on that amount, may be supposed to vary directly with its area of cross section, but the resistance of the conductor and therefore the loss of energy in it, will vary inversely with its cross section. Hence the interest on the cost of the conductor and the cost of the current wasted in a year will vary inversely with each other. Now the sum of two quantities which vary inversely is a minimum when the two quantities are equal.

The most economical size will therefore be that with which *the cost of current wasted in a year will equal the interest on capital invested in conductor.* Hence

$$\frac{4\,p\,n\,C^2\,l\,R^{sp}}{745\,\pi\,d^2} = \frac{i\,g\,W\,l\,\pi\,d^2}{4} \qquad (8)$$

$$d^4 = \frac{16\,p\,n\,C^2\,R^{sp}}{745\,\pi^2\,i\,g\,W} \qquad (9)$$

It will be noticed that l cancels from equation (8), therefore the size of conductor is independent of its length.

EXAMPLE.

Let p ... ... = ·03
„ $n = 365 \times 6$ ... ... = 2190 hours
„ c ... ... = 1000 ampères.
„ R^{sp} pure copper, inch, at 0° C. = ·00000064645 ohms.
„ i ... ... = 8 per cent.
„ g per lb. *in situ* ... ... = 30
„ w cubic inch ... ... = ·32523 lbs.

Log. 16·	...	= 1·204120	Log. 745	...	= 2·872156
„ ·03	...	= 2·477121	„ π^2	...	= 0·994302
„ 2190·	...	= 3·340444	„ ·08	...	= $\bar{2}$·903090
„ 1000000·		= 6·	„ ·30	...	= $\bar{1}$·477121
„ ·00000064645		= $\bar{7}$·810538	„ ·32523	...	= $\bar{1}$·512192
		2·831223			1·758861
		1·758861			
		4)1·072362			
Log. d.	...	= ·268090			

d = 1·8539 in.

From equation (9) it appears that the area of cross section varies with the current, hence a copper conductor that carries 10 ampères under the conditions in the above example, should have a diameter of

$$\frac{1{\cdot}8539}{\sqrt{\frac{1000}{10}}} = {\cdot}18539 \text{ in. (nearly No. 5 gauge).}$$

It is important now to consider the heat generated in the conductor by the current. The heat in water gramme centigrade degrees generated by any current in t seconds is expressed by the equation :

$$H = {\cdot}24\ C^2\ R\ t \qquad (10)$$

The ratio between the gramme centigrade and pound Fahrenheit degrees is $\frac{9}{5 \times 453{\cdot}54}$, which multiplied by ·24 gives ·00095251. Hence the heat in pound Fahrenheit units will be

$$H = {\cdot}00095251\ C^2\ R\ t \qquad (11)$$

Substituting for R its value in (3)

$$H = {\cdot}00095251\ C^2\ t\ \frac{4\ l\ R^{sp}}{\pi\ d^2} \qquad (12)$$

The temperature to which the conductor will be raised in any time, supposing no heat is radiated or conducted away, will be the quotient of the whole amount of heat divided by the weight of the conductor multiplied by the specific heat, H^{sp}, of the material composing it.

$$T = \frac{H}{\text{weight} \times H^{sp}}$$

Substituting for weight its value in (5)

$$T = \frac{4\ H}{W\ l\ \pi\ d^2\ H^{sp}} \qquad (13)$$

Finally substituting for H its value in (12)

$$T = {\cdot}00095251 \times 16\ \frac{C^2\ t\ R^{sp}}{W\ \pi^2\ d^4\ H^{sp}} \qquad (14)$$

Since, in the above equation, C^2 and d^4 are the only variables, T is constant, under the same conditions, for wires of different sizes each carrying its most economical current.

EXAMPLE.

The copper wire in the last example with current of 1,000 amperes, t one hour or 3600 seconds, H^{sp} of copper ·09515.

Log.	·00095251	= $\bar{4}$·978869	Log.	·32523	= $\bar{1}$·512192
„	16·	= 1·204120	„	π^2	= 0·994302
„	1000000·	= 6·	„	d^4	= 1·072362
„	3600·	= 3·556303	„	·09515	= $\bar{2}$·978409
„	·00000064645	= $\bar{7}$·810538			0·557265
		1·549830			
		·557265			
Log. T ...		= ·992565			

T = 9°·8302 Fah.

In the above example it is assumed, as has been before stated, that no heat is lost by radiation or conduction. But it is evident a conductor whose temperature rises only at the rate of about 10° Fahrenheit per hour would soon reach a point where the heat given off would equal that acquired; hence it could never become many degrees hotter than surrounding objects, especially if Prof. Forbes' suggestion of making the conductor flat was adopted.

I have no data for computing what this final difference of temperature would be for a wire buried in the ground (the only way to dispose of conductors carrying large currents), and it would evidently vary in different localities, but it is safe to assume that the difference would be so small that it would only be objectionable by slightly increasing the resistance of the conductor.

W. L. HOOPER.

Physical Laboratory,
Tufts College, *May 7th*, 1884.

ON A RELATION BETWEEN THE CO-EFFICIENT OF THE THOMSON EFFECT AND CERTAIN OTHER PHYSICAL PROPERTIES OF METALS.*

By SHELFORD BIDWELL, M.A., LL.B.

HAVING observed that the co-efficient of the Thomson effect is generally positive in those metals which have a great specific resistance and specific heat, and negative in those which are distinguished by a great coefficient of expansion, the author endeavoured to find an empirical formula expressing the coefficient of the Thomson effect in terms of the specific resistance, specific heat and coefficient of expansion. Though he was not altogether successful he believes that the subjoined table points to the existence of a close relation between them.

I. METALS.	II. Coefficient of Thomson effect.	III. $H \times R - E^2$	IV. Last Column divided by 2400.
Ni.	5·12	12320	5·13
Pe.	4·87	9918	4·13
Pd.	3·59	7086	2·95
Pt. (soft) .	1·10	2309	0·96
Pt. (hard)	0·75	...	...
Mg. ...	0·95	1384	0·58
Pb.	0	−604	−0·25
Al.	−0·39	1942	0·81
Sn.	−0·55	−868	−0·36
Cu.	−0·95	−1137	−0·47
Au.	−1·02	−1172	−0·49
Ag.	−1·50	−2246	−0·94
Zn.	−2·40	−2355	−0·98
Cd.	−4·29	−4958	−2·07

The first column contains the names of all the metals, except alloys, given in Tait's thermo-electric diagram, (Trans, R. S. E., vol. xxvii, p. 125.) The second column gives the coefficients of the Thomson effect : these are taken from Everett's table ("Units and Physical Constants," p. 151) which is based upon Tait's diagram.

H, R and E being numbers proportional to the specific heats, specific resistances and coefficients of expansion of the various metals, $H \times R - E^2$ gives the numbers in the third column. H = spec. heat × 10^3, R = spec. res. × 10^3, E = coefft. of exp. × $10^8 \div 34$. The multiples 10^3 and 10^8 were used merely for the convenience of getting rid of decimals; the divisor, 34, was so chosen that while the ratio of the first number to the last in column III. should be as nearly

* Abstract of a paper read at the meeting of the Royal Society, May 8th.

as possible equal to the ratio of the first to the last in column II., the number corresponding to lead in column III. should at the same time be as near zero as possible. Both conditions could not be exactly fulfilled at once.

Column IV. gives the numbers in column III., divided by 2,400, to facilitate comparison with column II.

It will be seen that, with one exception, the order of magnitude of the numbers in column IV., is exactly the same as the order of those in column II. The rate of decrease is, however, not the same, the numbers diminishing too rapidly in the upper half of column IV. and too slowly in the lower half.*

THE EFFICIENCY OF SECONDARY GENERATORS.

M. GAULARD has replied to the criticisms of M. Hospitalier on the Gaulard-Gibbs secondary generators with the following unintelligible letter, which we find published in *L'Electricien* :

"I must think that your severe comments are the result of a false interpretation, both of our system of distribution in general, and of the terms of Dr. Hopkinson's report.

"As regards this last document, you say in effect: 'After having admitted that the electro-dynamometer is subject to indisputable theoretical objections for measuring alternating currents, Dr. Hopkinson uses this apparatus for determining the efficiency of the secondary generator, and we are expected to accept the figure, 86 per cent., found by a method which the author himself considers objectionable. This would be too credulous !'

"The report of Dr. Hopkinson establishes the rendering of this secondary generator, by means of the method which you have yourself previously recommended, that is to say, by the aid of the Thomson electrometer, at 86 per cent.

"In order to verify the result thus obtained, he makes use of a Siemens electro-dynamometer, intended for measuring current strength. He finds by this means an efficiency of $\frac{201{\cdot}4}{230} = 87{\cdot}5$ per cent., and concludes from this that considering the great difference which exists between the two methods of measurement, the results agree closely enough to allow of giving the minimum rendering of 86 per cent.

"Dr. Hopkinson, in the first part of his report, says that the electro-dynamometer for measuring alternating differences of potential, also called the watt-meter (*sic.*), is susceptible of certain criticisms, but it never entered his thoughts that the electro-dynamometer, or ampèremeter, constructed by Siemens, and which practice has largely proved, could give incorrect results.

"As regards the system in general, you accuse me of establishing designedly a confusion between distribution and transmission. I think that it is you who confound 'division with distribution,' when you assert that previously existing systems can allow of the distribution of energy.

"In fact, the Edison system, whatever be the resistance of the lamps employed, only allows of giving to each consumer a portion of the same original electric quality (*sic*), and consequently imposes upon them the necessity of using identical consuming apparatus.

The Brush system, with its 40 lamps in series, imposes upon the consumer the manipulation of currents of high potential, which you yourself declare to be dangerous, and does not allow of varying at will the employment of the current supplied to him.

"As for the Marcel Deprez system, supplying at Grenoble 102 incandescent lamps, it is impossible to take into serious practical consideration an experiment which can only succeed under the condition that none of the lamps supplied can be thrown out of use without causing the immediate extinction of all the lamps illuminated.

"Therefore I hope that these remarks will induce you to admit that there yet exists no other system of distribution than that which we have invented, and which is the only existing solution of the problem thus stated; Transmission to a great distance of electric energy under the most economical conditions possible in the establishment of conductors and the recuperation of the energy, distributing this latter under variable forms, and independently of potential, so as to allow each consumer to utilise the portion of energy distributed to him for supplying apparatus of any kind, that is to say, incandescence lamps of any resistance, arc lamps of all systems, motors, &c., &c.

"It is well known that secondary generators furnish *ad libitum*, electric currents of very low potential; the initial tension employed for the transmission of the energy in no way affecting them, a notable difference from the Brush and Marcel Deprez systems.

"However, this may be, practical experiments which we have made upon the Metropolitan Railway have appeared, from the industrial and economical point of view, sufficient to induce the gas company which supplies this railway to propose lowering their terms from 3s. per thousand cubic feet to 2s. 10d., and we do not know of any other system of division or transmission of electricity which has ever had such an influence."

M. Hospitalier tersely replies that it is impossible to discuss with an inventor who confounds the watt-meter, the electro-dynamometer, and apparatus for measuring alternating differences of potential (!)

For ourselves, without again entering into the technicalities of this matter, we express regret that the apparatus of MM. Gaulard and Gibbs is no longer to be seen in action on the stations of the Metropolitan Railway.

M. CARPENTIER'S NEW RESISTANCE BOBBINS.*

By AUG. GUEROUT.

WHEN speaking in a former article of the resistance-boxes constructed by M. Carpentier, we pointed out the use in these boxes of bobbins of a new construction. We will now give some details on the use of these bobbins as patented by M. Carpentier.

The greatest difficulty in the construction of resistance bobbins lies in the regulation of the length of the wire. We cannot change their length without unsoldering one of the extremities of the wire to displace it on the attachment piece, and making a new joint at another place. These operations naturally heat the wire, which modifies its resistance and falsifies the regulation, unless we wait until it is completely cold. This renders the operation extremely tedious, and even then it is scarcely possible to arrive in this manner at a final regulation. Thus, after having brought by this process the resistance of the bobbin to a value a little higher than that which it ought to have, the operation is completed by scraping the solder, little by little, until the value required is arrived at. This last process is very long and delicate.

The ideal would be to be able to vary the length of the wire, as is done in rheostats, and it is in order to approach this ideal as closely as possible that M. Carpentier proposes to insert in the wire of these bobbins

* With regard to aluminium, it is suggested that Matthiessen's determination of the spec. res., 0·029, is possibly too high. Moreover, the author found experimentally that the Thomson coefficient of the specimen of aluminium which he used was slightly +, instead of − as given in column II.; it is also shown as + in the diagram at p. 178 of Jenkin's "Electricity." If its spec. res. were as high as 0·026, it would come between magnesium and lead in column IV.

* *La Lumière Electrique.*

a true rheostat in miniature, placed in the central hollow of each bobbin. By working these it is possible to obtain the small variations of resistance necessary for regulation.

The rheostat is formed of two parallel helices of nickel silver connected at the end, and insulated one from the other by being lodged in a paraffined twist inserted in the wood of the bobbin. The current

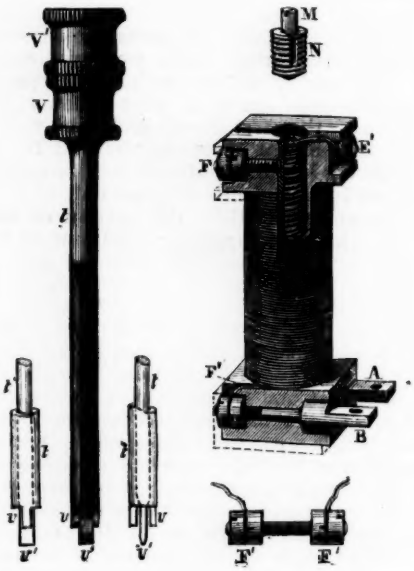


FIG. 1. FIG. 2.

descends by one of these spirals, and reascends by the other, and the two helices thus arranged recall those interlaced staircases which are sometimes seen in certain edifices.

To vary the resistance of the rheostat, there is placed in the interior of the double spiral a movable metallic step. In this manner the current descends only to the place where the step is placed, and traverses thus a resistance so much the greater as the step is placed farther in the interior of the helices.

To give an idea of the small space occupied by a rheostat of this kind, we may say that the central tube of the bobbin in which it is placed is 5 millimetres in diameter by 6 centimetres in length. The construction of this rheostat and its placing are very delicate. The boring out the wood has to be done with much care, and requires the use of a special screw-tap, to avoid tearing the wood. It is quite necessary that the wood should be coated with paraffine. If this precaution has been neglected the true resistance of the double helix is found reduced to one-fourth after its introduction into the bobbin. If, on the contrary, the paraffine has been properly applied, the resistance of the nickel silver wire is identically the same before and after its introduction.

The two helices form part of the same wire, and they are constructed and introduced into the bobbin by a single operation and by means of a simple and ingenious mechanism, the description of which would take up too much space. This mechanism seizes the wire by its middle, and in less than a second fits it into the place

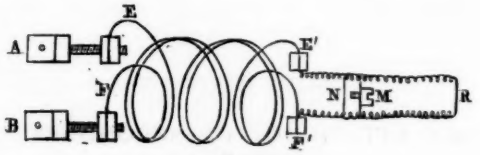


FIG. 3.

intended for its reception, and withdraws in an instant, leaving the double spiral perfectly formed.

The movable bearings, represented in part in fig. 2, are each formed of two pieces; an expansion nut, N, with a thread cut in such a manner that it may be screwed into the double helix of the rheostat, and a central conical screw, M, intended, when the nut has been brought into any position in the rheostat, to separate its two parts from each other, and press it thus against the nickel silver wires. This pressure is indispensable for obtaining a good contact, and it may, if produced without caution, be rendered strong enough to burst the bobbin. The final screwing up the nut is not done until the regulation is complete. (Fig. 4.)

To work the bearings in the interior of the rheostat there is employed a double-action screw-driver. This screw-driver (fig. 1) is formed of a tube and a rod of steel, both concentric, both cut to a slope like ordinary screw-drivers, but having this peculiarity, that the rod, t', v', inclosed within the tube, t, v, is movable in its interior. By means of this arrangement the double edge of the tube can enter into the slit of the nut, whilst the end of the rod enters into the slit of the conical screw. If the head, V, of the tube is turned the bearings are moved in the double helix; as soon as this is in its place, by turning the head, V', we act upon the conical screw, and thus fix the bearings. For

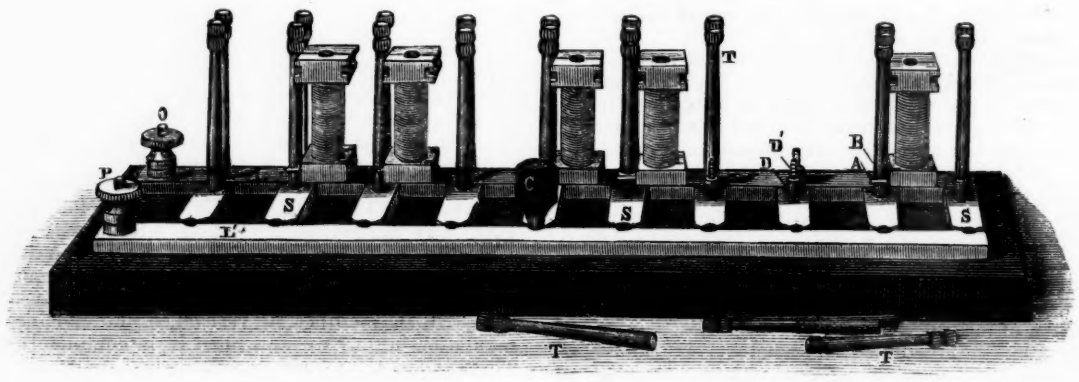


FIG. 4.

their subsequent removal the order of these operations is reversed.

The resistance bobbins themselves are coiled round with two parallel wires of nickel silver covered with silk. They are only tried at first by measuring their length, thanks to a previous operation made upon the bobbins, which hold the stock of wire. On receiving a bobbin into the workshop it is submitted to a rapid reeling process in a very simple apparatus, which measures its total length. Its resistance is then

determined by means of a Wheatstone's bridge, and from these two measurements is deduced the metric length corresponding to a given resistance. This figure is inscribed upon the bobbin, and enables a simple measurement to be substituted for every determination of resistance.

Fig. 3 shows how the different parts of the resistance are connected among themselves. The wires, E, E′, F, F′, are connected on the one hand to nuts communicating with the ears, A, B, intended to be attached to the resistance box. On the other hand, the ends of the wires are fixed to other nuts, to which is attached the small rheostat, R, fitted with its bearings.

Fig. 2, which represents the bobbin in its material size, shows the manner in which the ends of the wires are attached to the different nuts. Each of the upper nuts, *e.g.*, F′, F′, represented at the bottom of the figure, receives at one of its ends one of the wires of the rheostat, and the other one of the wires of the bobbin. The nuts of the ears, A and B, receive the other ends of the latter wires.

When the resistance bobbins are constructed they are gauged by means of the apparatus, fig. 4. Two long bands of thick copper, L, L′, are connected with the Wheatstone bridge by means of the studs placed at their ends. Between these two bands, but not touching them, are placed the shorter transverse bands, S, S, . . which form, as it were, the steps of a ladder placed horizontally. Each of these pieces may be connected to the anterior band by a movable pin, C. At its other end it supports a piece cut with a screw-thread, intended to receive the ear, A, of one of the resistance bobbins. Another similar piece, D′, is fixed opposite to it upon the posterior band, and receives the other ear, D. Long rods, T, T, going beyond the bobbin, serve to tighten the ears, A and B, so that the contact may be good.

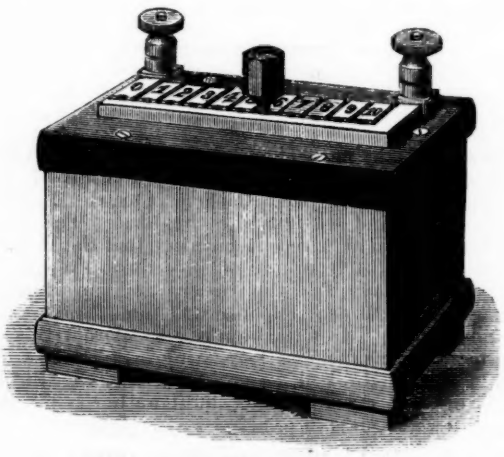


FIG. 5.

A certain number of bobbins being thus placed upon this gauging table, their resistance may be successively regulated without changing anything but the place of the pin, since in general we only place upon the table at the same time bobbins which should have an equal resistance. This procedure renders it easily possible to verify the identity of the bobbins among themselves, which is an advantage. Except as regards the length of the screw-rods, the ultimate attachments of the resistance boxes are identical with those of the gauge table, so that the transfer of the bobbins into the boxes does not occasion any variation of resistance. Besides, when the bobbins are in the box their standards may be verified a second time (fig. 5).

The figs. 5 and 6 give an outside and inside view of a complete box, of 10 identical bobbins. It is easy to understand according to these figures the arrangement of the bobbins. The 11 blocks placed upon the box and marked from 0 to 10, correspond within to a range of 11 pieces, similar to the pieces, D, D′, of fig. 4. The resistance bobbins are fixed to these pieces on both sides of the range, so that they are all connected in tension and so that each piece, D, serves as the junction point for two consecutive bobbins. The last piece, 0, is connected to one of the studs of the box. The other stud is fixed to a long band of copper which may be connected by means of the movable pin with any of the blocks, thus bringing the corresponding number of bobbins into circuit.

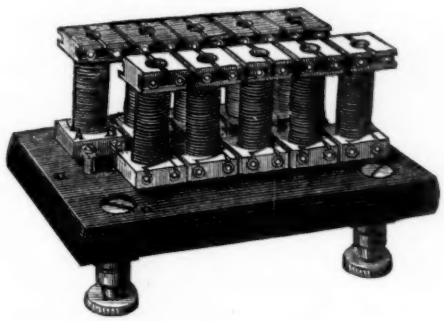


FIG. 6.

With bobbins of different values the regulation is more or less easy for the same rheostat introduced into the interior of the bobbin and for the same sensitiveness of the galvanometer. The lower the resistance of the bobbins the more difficult is the regulation. For bobbins of 10—100 ohms it is very easy. For those of 1,000 ohms it is necessary to construct a rheostat with a finer wire.

For bobbins of one ohm M. Carpentier has employed for three years the two wires in derivation indicated by Mr. S. P. Thompson (see *La Lumière Electrique*, March 8th, 1884). There is, however, this difference that Mr. Thompson connects the two wires in derivation with the studs of the bobbin, whilst M. Carpentier only places the derivation on a fraction of the bobbin, about $\frac{1}{9}$. The derivation is then formed quite simply by the regulation rheostat.

What we have said above concerning the difficulties of gauging will suffice to show the advantages of the apparatus thus described and to show that we have here an ingenious and well-planned system certain to do good service.

THE DETERMINATION OF THE OHM.

By MM. E. MASCART, F. DE NERVILLE, and R. BENOIT.

IN order to respond to the programme of the International Commission of Electric Units, we have arranged a series of experiments to determine the dimensions of the column of mercury at zero, which represents the unit of practical resistance, or the value of the Ohm. In this memoir we can give merely a brief summary of the methods and the results.

The absolute resistance of a conductive circuit has been measured by the induced current which is developed when this circuit is displaced in the terrestrial magnetic-field (Weber), or when it is submitted to the action of a neighbouring current (Kirchhoff). These two methods have the advantage of presenting many characters in common, and of permitting the use of the same instruments, so as to admit of a mutual control.

To eliminate systematic errors we constructed five bobbins, two of which were covered with several distinct wires, and we employed 17 different combinations, of very unequal values.

In the first method we caused to revolve in a half-circuit around a vertical axle a frame which, at the outset, was perpendicular to the magnetic meridian,

observing the impulse given by the induced current to the needle of a galvanometer introduced into the circuit. The resistance is given by the expression

$$(1). \qquad R = 2 S \frac{H}{h} g \frac{\pi}{\tau \theta}$$

in which S denotes the surface developed by the wire of the frame, H and h the values of the horizontal component of the magnetic-field at the points where are the frame and the ballistic galvanometer, g the constant of the galvanometer, *i.e.*, the action of the unit of the current upon the needle, θ the angle of impulse corrected by the extinction, and τ the duration of the infinitely small oscillations, all reductions having been made.

In the second method, the induction upon the frame is produced by the inversion of a neighbouring current. If we call the inducing current I, and M the coefficient of mutual induction of the two circuits, and preserving for the other letters the same signification, the resistance of the induced circuit is

$$R = 2 M \frac{I g}{h} \frac{\pi}{\tau \theta}$$

The intensity, I, being determined by the deviation, a, of a tangent-galvanometer, of which the elements are h' and g', we have

$$(2). \qquad R = 2 M \frac{g}{g'} \frac{h'}{h} \frac{\pi}{\tau \theta} \text{tang. } a.$$

In order to eliminate from the formula (1) the quantities, H, h and g, we utilise the frame itself as a tangent-galvanometer, and pass into the frame and the galvanometer a common current, which gives the deviations Δ and δ. If G is the constant of the frame, we have

$$(1)'. \qquad R = 2 S G \frac{\text{tang. } \delta \, \pi}{\text{tang. } \Delta \, \tau \theta}$$

In like manner we eliminate the quantities, h, g, h' and g', from the formula (2), observing the deviations δ and δ', produced by a common current in the balistic galvanometer and the tangent-galvanometer, which gives

$$(2)'. \qquad R = 2 M \frac{\text{tang. } \delta}{\text{tang. } \delta'} \frac{\pi}{\tau \theta} \text{tang. } a.$$

The expressions (1)′ and (2)′ contain merely direct experimental data and the quantities, S, G and M, which are determined by the dimensions of the bobbins.

The elements, S and G, of a bobbin, with a rectangular neck, are deduced by known methods from the length of the wire, the number of coils and the dimensions of the neck.

The coefficient, M, of the mutual induction of two bobbins may be calculated by means of the elliptic integrals, according to a method indicated by Maxwell. But this calculation appears to us much simpler if effected by the use of a series developed according to the increasing powers of the ratio of the mean radii.

When, according to Weber's method, the different wires of the multiple bobbins are united either in series or in derivation, the quantities, G and S, which enter into the formula (1)′, may be deduced from those which relate to distinct wires by the ordinary law of derived currents, the application of which is legitimate. We calculate in the same manner the coefficient of mutual induction of a bobbin with a single wire and a bobbin with multiple wires, grouped partially either in series or derivation.

The apparatus has been set up in the Pavillion Français, in the Park of Trianon, which the Minister of Public Instruction and of the Fine Arts, has kindly placed at our disposal. We have thus made more than 50 complete series of observations with various combinations of bobbins, and, according to both methods, each series requiring from $2\frac{1}{2}$ to 3 hours. The resistance of the circuit being compared each time with that of a standard (B.A.U.) of the British Association, there results, as the general mean—

B.A.U. = 0·9861 ohm.

To find the value of this resistance in a column of mercury we constructed four tubes of about 1 square millimetre in section, and gave them such a length that when full of mercury they had the same resistance as a standard B.A.U.

These tubes had been previously graduated in parts of equal length, and calibrated with the greatest care at the International Office of Weights and Measures, by the permission and with the kind assistance of M. Broch. Each of the tubes was adjusted at its ends in vessels of glass with a large aperture, filled with mercury in a vacuum, and its resistance compared with that of a standard B.A.U. at the ordinary temperature and in melting ice.

It has been experimentally proved that filling in air does not affect in an appreciable manner either the relative weights in calibration or the electric resistance.

The term of correction for the resistance at the extremities has been calculated according to Lord Rayleigh's formula. The accuracy of this formula has further been directly verified by cutting a tube into several portions, connected together by vessels with a large aperture, and determining the variations of resistance produced by each of the segments.

Closely accordant determinations for the four tubes gave :—

1 mercurial unit = 0·95374 B.A.U., and consequently

1 mercurial unit = 0·9405 ohm.

Hence the length of a column of mercury at zero of 1 square millimetre in section, which represents the value of the ohm, is 1063·3 millimetres.

This result is the crude mean of the experiments without any distinction. A more careful consideration in which the experiments are selected, which appear most trustworthy, whether from the magnitude of the impulses or in general from the conditions under which the sensibilities of the two galvanometers were compared, leads us to regard the figure, 1063, as being a little too high.—*Comptes Rendus.*

NOTES.

Electric Lighting.—The Carlisle Town Council have a bill of close upon £500 to pay as a result of their action in procuring the Carlisle Electric Lighting Order, 1883, and do not like the idea. The Town Clerk explained at a recent meeting that the Board of Trade altered their course of procedure after it was decided to apply for the Order, and an immense amount of additional expense was thus thrown upon the applicants. Mr. Creighton remarked that this was another warning against legislating in a panic, which Mr. Chamberlain had done in passing the Electric Lighting Act, causing every local authority to adopt expensive measures to protect its own rights.

The Electric Lighting (Provisional Order) Bill was read a third time and passed in the House of Lords, on Thursday, the 15th inst.

Over 120 incandescent lamps were employed by the Electrical Power Storage Company in lighting the ball-room at 6, De Vere Gardens, Kensington, last week, on the occasion of Lady Cooper's ball. The lamps were fed from Faure-Sellon-Volckmar accumulator cells, which had been brought in a couple of vans, and were stationed in the coach-house at the back of the mansion. The effect when the lamps were lighted was very pleasing, the temperature of the rooms was not raised to any appreciable extent, and the result of the light on colours and complexions was most agreeable. The electricity was generated at the works of the Electrical Power Storage Company, Millwall, and was therefore conveyed from a distance of about 10 miles. Each van contained 30 accumulator cells capable of lighting and maintaining in full brilliancy about 130 incandescent lamps for a period of about 10 hours. The purity of the atmosphere as compared with that of rooms lighted with either gas or candles gave rise to much comment, and the experiment was deemed successful.

It is stated that the Town Council of Brussels have resolved to hold an exhibition of apparatus for lighting by gas and electricity at Brussels in 1887. It was at first proposed to hold it this year, but the consideration that Antwerp is to be the scene of an exhibition this year, at which electricity will be prominent, caused the Brussels project to be postponed.

The Edison and Swan Company's installation of incandescence lamps at the Health Exhibition will comprise about 1,000 incandescence lamps, of which rather more than one-half will be Edison, and the rest Swan lamps. All the lamps are placed at a considerable distance from the machine-room, and as they are all situated in one direction as regards the machines and are all on the same circuit, visitors to the Exhibition will be able to judge what sort of thing an electric light cable to convey current for 1,000 lamps actually is. In addition to the lamps installed by the company itself a large number of Swan lamps are used by other exhibitors, which will make the total of Swan lamps in the exhibition between 3,000 and 4,000. For the first 150 feet from the dynamos, Edison electric tubing with an area of 1·054576 square inches of copper surrounded by insulating compound and encased in cast iron pipes, has been employed, each cable being in a separate pipe; for the remainder of the distance, that is, about 650 feet, a similar Edison tubing, but with an area of 0·776826 square inches of copper, has been used. The branch cables and wires are all heavily insulated with India rubber, tape, &c., and are all mechanically separated in the manner invariably adopted by the Edison and Swan Company. The relative resistance of the main and sub-main cables, which measure about 0·02 of an ohm, to that of the lamps has been calculated to allow of a fall of potential between the machines and lamps of about 12 per cent., assuming the working load to be not less than 1,000 lamps, all situated at the extremity of the cable. At a distance of 530 feet from the dynamos a branch cable is taken off for supplying the dining-rooms and kitchen, and the cables for supplying the vestibule and the entrance-hall are taken off at a distance of 800 feet, which may be considered the end of the main cables. It will thus be seen that the main cable forms a loop of which the total length is nearly a third of a mile, its section being such that at no point, with a full load, will the current passing through it ever exceed 1,000 ampères per square inch of copper. The lamps, with hardly any exception, are all high resistance lamps, requiring an electromotive force of 90 volts; those of the Edison type taking about 0·75 and those of the Swan about 0·7 ampère each, giving respectively a light equivalent to 16 and 20 candles. The dynamos, 10 in number, are of the Edison L type, each capable of sustaining 150 lamps, the speed being calculated at 950 revolutions per minute, which will allow a useful margin in case of reduction in speed owing to accidents or other causes. These machines have been used as being the most readily available, but it is intended as soon as possible to substitute in place of some of them one or more of Mr. Edison's newest type of dynamo. Two separate countershafts driven off the main countershaft have been fixed, each one driving five machines. Each set of five is arranged to be stopped or started, one by means of an Addyman's friction clutch and the other by striking the belt on to a loose pulley. The entire ten machines are connected in parallel circuit to the main cables, and each of the ten can be controlled entirely at will both as regards the field and the main circuits. The field circuits of all the dynamos are in multiple arc between the mains, in two groups of five each, each subdivision being controlled by a variable resistance thrown in at pleasure. The total field resistance is two ohms, and the total field exciting current is about 50 ampères. By this method of throwing in a variable resistance the electromotive force will be so governed as to maintain a constant potential of about 90 volts at the furthest end of the main cables, the electromotive force at the machines being probably rather over 100 volts. About 5,000 watts will therefore be expended in the fields. With the exception of the lamps in Messrs. Verity Bro's. large flower basket chandelier, which will be remembered in connection with the Edison Company's exhibit at the Crystal Palace Exhibition, and those in a handsome cut glass chandelier made by Defries & Son, the lamps have all been placed on simple wooden supports, the majority being arranged in groups of five and fitted with coloured shades; the remainder being fixed as single light pendants.

Messrs. Woodhouse and Rawson inform us that more than one quarter of the incandescence lamps used in the Health Exhibition will be of their manufacture. The chief exhibits consist of 1,000 lamps on the Hammond Company's Ferranti machine, lighting up the dining-room, aquarium, &c.; 250 in the smoking galleries, 75 in the water companies' exhibit, and 100 in the conservatory of the Prince of Wales' pavilion. In addition, the Wolverhampton Storage Company, Messrs. H. Edmunds & Co., Oppermann Bros., and other exhibitors, will use the Woodhouse & Rawson lamps.

The whole of the electric light machinery at the Health Exhibition is being driven from the Rodgers patent wrought-iron pulleys, which are manufactured solely by Hudswell, Clarke & Co. We learn that this firm has already supplied to various purchasers over 40,000 of these pulleys.

The Anglo-American Brush Electric Light Corporation has obtained the order for lighting with its arc and incandescence systems the buildings and adjacent grounds of the International Forestry Exhibition to be held in Edinburgh during the months of August and September of the present year. The plant to be employed, which is on hire during the term of the Exhibition, will be four No. 7 Brush "arc" machines, working 46 of the corporation's new Brush-Sellon lamps; these lamps will be employed for lighting the interior of the building, as they burn with a remarkably clear and steady light, this being so essential a condition of indoor working. As well as these lamps, the above machines maintain 15 Brush arc 2,000 C.P. lamps, which are used for illuminating the grounds and outer portions of the building, making 61 "arc" lamps in all. Besides this "arc" plant, 500 of the corporation's "Victoria" incandescence lamps will be distributed over the buildings for lighting the entrance corridor, refreshment rooms, &c.; these lamps will be driven off two of their "E_2" Victoria machines, "compound" wound, each capable of maintaining 250 20 C.P. "60 volt" lamps.

The Anglo-American Brush Corporation has had one of the Victoria machines, "D_2" size, at work at the Furniture Trades Exhibition which has been held at the Agricultural Hall. The machine was working 100 "Victoria" lamps which were distributed about the building; the stalls illuminated being those of Messrs. Druce & Co., Messrs. Proctor & Co., and others. The whole of the work was successfully carried out and worked by Messrs. Gretton, Mynn & Co., electrical engineers and contractors.

The Hammond Electric Light Company is now fitting two large steamers on the New Zealand line, belonging to the Shaw, Savill and Albion Company, with the Ferranti machines and the Swinburne "glow" lamps.

It is said that the number of incandescence lamps required to light the building of the Cotton Exhibition of New Orleans, which is to be in readiness for the reception of articles by the middle of August, will be no less than 15,000. If the arc system be used, 700 lamps will be necessary, and in either case it is intended that the grounds shall be illuminated with five arc lights of 36,000 candle-power each.

Mr. Henry Edmunds informs us that he has now made arrangements at his factory in Halifax for the manufacture of the "Hochhausen dynamos, &c.," under the superintendence of Mr. P. J. Charles, late of Messrs. Emmerson and Murgatroyd's works.

Telephonic.—Latest advices from the River Plate report 2,200 Bell telephones in use there, of which 1,300 are employed in the city of Buenos Ayres in connection with the exchanges of the United Telephone Company of the River Plate; 400 in Monte Video for the exchanges of the new company, "La Uruguaya," recently started in that city; and 500 in connection with various exchanges in Rosario, Cordoba, Concordia, and in the provinces of the Argentine Republic generally. The United Telephone Company of the River Plate own the Bell patents for the River Plate. Gower-Bell instruments are used by the River Plate Telephone and Electric Light Company in connection with their exchanges at Buenos Ayres and Monte Video, which also have a large number of subscribers.

Telephones and the Post Office.—Mr. Fawcett, in reply to Mr. Gray, on Thursday, the 15th inst., stated that 177 telephones were in use by the Post Office for exchange purposes on the 31st of March, 1882; 598 on the same date in 1883; and 954 on the same date in the present year. The total number of such instruments acquired by the Post Office 5,251, and the department had the right, under agreement, to call upon the United Telephone Company to supply about 15,000 more. Three hundred and thirty-two telephones had been sold by the department, and the aggregate price received for them £3,315. No conditions were imposed on the purchasers.

Telegraphic Communication with Light Vessels.—In answer to Mr. Arnold, Mr. Chamberlain said, in the House of Commons, on Friday, the 16th inst., the Trinity House informed him that the electric cable for effecting communication between the Sunk light vessel and the shore was ready, and all arrangements on shore made; but that mechanical difficulties had necessitated an entire change in the original plan for connecting the cable with the vessel. Moorings upon an altered plan were now reported nearly ready for testing, and if they proved adequate it might be hoped that communication would be established during this summer.

The West India and Panama Telegraph Company, Limited.—The secretary states that during the interruption of the International Ocean Telegraph Company's cables between Key West and Havannah, messages to and from the West Indies will be conveyed between those points by a special steamer which has been chartered for the purpose, and without change of rates.

Cable communication between Trinidad and Demerara was interrupted when the mail left.

Telegraph Revenue.—The total receipts into the Exchequer on account of the telegraph service from the 1st April, 1884, to 17th May, 1884, were £210,000, an exactly similar sum having been received in the corresponding period of the previous year.

Telegraph Stores.—Tenders are invited by the North Eastern Railway Company for the supply of telegraph apparatus, telegraph wire, and line stores. Tenders to be sent to the secretary at York, by the 29th inst.

Field Telegraphy.—The First Division Royal Engineer Telegraph Corps will move from Aldershot to Chobham early next month, and encamp for a month's technical instruction.

A Committee has been ordered to assemble at Aldershot and report on the values of the various methods of effecting telegraphic communication between outposts and the main body in the field.

Electric Fire Alarms.—On the recommendation of the Sub (Fire Brigade) Committee, the Watch Committee of the Leeds Town Council last week decided to fix electric fire alarms in a certain number of places in the principal parts of Leeds. These alarms will be fixed in walls or other suitable positions, and will communicate direct with the Corporation Fire Brigade Station in Park Street.

The War Telegram Case.—A new trial will, it is said, be moved for in the case of the Central News Telegraph Company *v.* the Eastern Telegraph Company and others in the matter of alleged appropriation of telegraphic news.

Committal of an Electrician for Contempt of Court.—Mr. Justice Pearson, on Saturday, upon the application of the United Telephone Company, committed Mr. Hebden, an electrician, to Holloway Prison, for a breach of an injunction forbidding him from infringing Bell's Receiver. Mr. Hebden has been previously committed to prison for the same offence, and the Judge said that he should now stay there long enough to learn the first elements of honesty.

Liquidations.—The liquidator, Mr. Philip A. Latham, will lay accounts of the manner in which the winding up of Ferranti, Thompson and Ince, the Yorkshire Brush Electric Light and Power, and the Warwickshire Brush and Electric Light and Power Companies has been conducted before general meetings, to be held at the offices of the Hammond Electric Light and Power Supply Company, Appold Street, Finsbury, on Wednesday, June 25th.

The Electrical Transmission of Power.—Messrs. de Meuron and Cuénod, of Geneva, have just completed a very important installation for the transmission of power by electricity in the establishment of Messrs. Blosch-Neuhans, at Biel, Switzerland, where 30 H.P. is transmitted to a distance of 1,200 mètres through a copper wire of 7 mm. The dynamos are of the Thury system, and only make about 500 revolutions per minute. The Thury machine is multipolar, having six poles; its form, which is that of a hexagonal prism, the facets of which are formed by the field-magnets, was adopted by the inventor in order to utilise as completely as possible the magnetic action of the iron employed in its construction. The armature resembles the Siemens armature, from which it only differs in the coupling of the wires.

Stranding of the Eastern Telegraph Company's Steamer "Retriever."—A telegram received at Lloyd's from Syra states: "The Eastern Telegraph Company's steamer *Retriever* stranded Saturday morning at North End, Santorin, and her forehold as far as the main tank is full of water, and, it is feared, bottom badly damaged. Discharging cable ashore to lighten the ship. Wired Syra for assistance. All that is possible will be done to save the ship if the weather keeps fine." A further telegram from Syra states: "*Retriever* grounded on reef, Cape Marvropetra, Santorin, at 10 a.m. Saturday morning. Fore part full of water. Now discharging cable and using every endeavour to get the ship off." The *Retriever* is an iron screw steamer of 457 tons gross. Built at Glasgow in 1879.

The Brighton Electric Railway.—Returns show that since the opening of the electric railway from the Brighton Aquarium to the east end of the town, over 23,000 passengers have used it. An agitation is being promoted against the venture, mostly by cabmen and omnibus proprietors, who complain that the line competes with them, but more serious opposition comes from a section of the Corporation, which professes to fear that the danger of horses taking fright at a noiseless electric car will detract from the popularity of the Undercliff Road.

Personal.—Colonel G. E. Gouraud has been elected Chairman of the board of directors of the Oriental Telephone Company, Limited.

Brush Midland Electric Light and Power Company, Limited and Reduced.—A petition has been presented in the Chancery Court for confirming a special resolu-

tion of this company for reducing its capital from £250,000 to £70,500.

South Kensington Mutual Electric Lighting and Supply Company, Limited.—Messrs. Burchell and Co., solicitors, 5, The Sanctuary, Westminster, have petitioned for the winding up of this company.

Size of Conductors.—Prof. George Forbes writes to us, too late however for our Correspondence columns, as follows:—In your last issue Mr. A. Gray declines for his brother the credit of having pointed out that Sir William Thomson's law fails for high currents. Perhaps I ought rather to have said that he showed that the law does *not* fail for currents *below* 5,000 ampères, as in speaking of choosing the right size of conductor he says that we need not pay attention to the heating effect for currents of less than that amount. Thomson's law does not give the loss of energy in heating the conductor, which of course had been known, but states the size of conductor which ought to be used, and, unless artificial cooling is resorted to, the over-heating causes it to cease to be a safe rule for currents over a certain amount.

Faure-Sellon-Volckmar Accumulators.—The Electrical Power Storage Company, Limited, notifies that a reduction has been made in the prices of the F.S.V. electrical accumulators, and that some new types are ready for supply. The ordinary accumulator cell with either glass or wooden boxes, contains 15 plates per E.H.P., the normal rate of charge being 20 ampères, and of discharge 30 ampères. A stronger pattern, with 13 plates, is also made, having a discharge rate of 26 ampères. These are intended for use where extra durability is desired, and where the accumulator may be liable to overcharging. For temporary installations and lighting purposes requiring portable accumulators not liable to be damaged by removal from place to place, cells are specially constructed in suitable boxes. Where small weight is required, combined with rapidity of discharge, as for motive power, laboratory work, &c., small plate cells are made, in either wood or ebonite boxes. Special cells are constructed, with plates of extra strength, for use as regulators for installations on the incandescent system. These entirely prevent the fluctuation in the light otherwise produced by every irregularity in the action of the engine. They can also be used in the customary manner for a small number of lamps during the hours that the engine is not running. Further particulars, as to price, &c., may be obtained on application at the office of the company.

Overhead Wires.—The Railway Commissioners, on Tuesday, gave judgment in the case of the Wandsworth District Board of Works *v.* the Postmaster-General, which raises the question of the expediency of erecting overhead wires in public roads. Sir Frederick Peel, in giving judgment, said the Postmaster-General was willing to lay the wires underground where existing wires were laid in that manner, but otherwise he proposed to carry the lines overhead. The Postmaster-General was at issue with the District Board, and where the number of wires overhead was as limited as he proposed, he saw no objection to the course he proposed to take. The rule of the Post Office was that in the case of five wires being erected, they would be carried overhead; and when there were as many as fifteen they should be carried underground—the course to be pursued with reference to the intermediate numbers being determined by the circumstances of each particular case. The parties being unable to agree, the matter was referred, under the Telegraph Act, to the police magistrate, Mr. Paget, whose award was substantially adverse to the District Board. The Board then appealed to the Railway Commissioners, before whom the case was gone into at great length. The Court agreed with Mr. Paget that underground wires should not be made compulsory all over the system subject to the conditions:—first, that the wires should be of copper; secondly, that all poles should be of iron; thirdly, that no wires should be placed over a public road or footway at less height than 30 feet; and, fourthly, that where the wires crossed over a public road or street, the side supports should not be at a less distance than 100 yards apart. The Court then dealt with and varied the award of Mr. Paget as relating to particular parts of the locality affected.

Pending the appeal in the action by the Wandsworth District Board of Works against the United Telephone Company, a similar action against the same company, brought by the Corporation of Bristol, has been ordered to stand over by Mr. Justice Lopes.

The Pilsen-Joel and General Electric Light Company.—We notice that this distressed company has made another call of 15s. per share. In its circular it is stated that 10s. is to enable it to carry out the resolutions recently passed and confirmed at its meeting of the 29th March, and 5s. is required "by the expenditure recently incurred in the installations at the Bethnal Green Museum and the International Health Exhibition, *the rentals from which form a satisfactory source of profit to the company.*" We are very much inclined to dispute the veracity of the latter part of this statement, for, admitting that the Bethnal Green installation *may* be profitable to some extent, we cannot think that the Health Exhibition is a source of much profit to the company. The arrangement, generally made with the electric light exhibitors is, we believe, that they supply the plant, whilst the exhibition committee finds the leads and pays the expenses of labour. It is not likely that an exception is made in favour of the Pilsen Company, and, therefore, we fail to understand how the profit mentioned as accruing from the Health Exhibition installation is obtained. Out of four of this company's machines placed at the exhibition we are informed that already two have been *hors de combat*, and half the space allotted to the company for illumination, left in total darkness. If this is true, the profit, if any, will, we should think, be soon absorbed in repairs.

The Institution of Civil Engineers.—The conversazione of this institution will be held at the South Kensington Museum on Thursday evening next.

Telegraphic Communication with Eddystone Lighthouse.—At a meeting of the Plymouth Chamber of Commerce, on Monday, the chairman said he had been in correspondence with Lloyds with reference to telegraphic communication with the Eddystone Lighthouse, and the matter had progressed very satisfactorily thus far. It was desirable now that a sub-committee should be formed to ascertain the expense of laying a cable from the Eddystone to land, and possibly a small company would have to be formed to put it in working order before it was taken over. Supposing the Trinity Brethren could be induced to see the value of telegraphic communication from a national and commercial point of view and would grant the necessary facilities, there would be no difficulty in bringing this long-desired matter about. It was suggested that some difficulty might occur from the fact that the cable would have to be laid on ground that was constantly trawled over, but the chairman said he was informed that that could be obviated.

The Philadelphia Electrical Exhibition.—The interest awakened in this exhibition, says the *Electrician* of America, is bearing fruit in the production of musty relics and interesting literary works long since forgotten. Among the latter is the London *Gentleman's Magazine* for the year 1753. In the December number for that year we read that at the meeting of the Royal Society in London "a gold medal was adjudged to Benjamin Franklin, Esq., of Philadelphia (not Maryland, as mentioned in our last magazine) for his useful discoveries in electricity. On this occasion the Earl of Macclesfield delivered a speech which greatly enhances the value of the prize, and does honour to the judgement, candour, and strict impartiality of the society."

And now, after a lapse of 131 years, the Franklin Institute of Philadelphia will reciprocate the "honour." One of the lasting results of the Congress of Electricians and the Exhibition will be the "Memorial Library." Before the Exhibition opens, a collection will be made of works upon electricity in all languages, and this library will remain there. To this end requests have been sent to electricians in all parts of the world, as well as to libraries and publishers, requesting aid in this laudable purpose, which, if accomplished, will give Philadelphia the best collection of works upon electricity to be found in America.

The Electrical Resistance of the Human Body.—Dr. W. H. Stone has written to *Nature* enclosing a communication on this subject from Prof. Dolbear. Touching the latter part of Mr. Dolbear's letter, we can add our own testimony to that advanced by him concerning the difference in the skin of individuals. One of the members of our staff has often had the indicator of a Wheatstone A.B.C. instrument worked through him from hand to hand, he thus forming the line. Another friend of ours had, however, such a horny skin, that no movement of the indicator ever took place when he was placed in a similar position to that of the first experimenter, and he would declare that the alternating current of these instruments scarcely affected his sense of feeling, although the previous observer could barely stand against the shock. Prof. Dolbear's remarks on the soaking of the skin entirely bear out our own comments in the ELECTRICAL REVIEW for June 23rd, 1883, when writing on some experiments made by Dr. Stone. This gentleman, however, was inclined at the time to make light of our opinions, which are now signally confirmed by the American physicist. The correspondence in our esteemed contemporary is as follows:—

"Will you kindly publish the inclosed from Prof. Dolbear? It furnishes a complete explanation of the discrepancy between his measurements of the resistance of the human body and those which I have recently made. At the same time, as I have pointed out to him, the fact that this resistance may sink below 500 ohms with 'soaked skin,' even if that be 'abnormal,' is of the highest physiological importance, and goes far to explain the hitherto mysterious deaths from accidental passage of a current through the body. Most of these, as Prof. Forbes remarked to me, have taken place with alternate, not continuous, current machines.

"Wandsworth, *May* 11. "W. H. STONE.

"College Hill, Mass., *April 23rd*, 1884.

"Dear Sir,—I have to acknowledge the receipt of your pamphlet 'On the Resistance of the Human Body,' for which I am obliged. I am glad to know that physiology has some one in its ranks who is interested in that line of work, and who knows what to do in order to settle such vexed questions.

"I have also seen in the last ELECTRICAL REVIEW that has reached me an article on the same matter, in which you refer to me and what has been published concerning some of my work, that needs a little elucidation. In the early days of telephony the experiment was often tried of making the human body part of the circuit in order to see how speech could be transmitted through the body, in the language of those days. Bell wanted to know what the resistance of the body was when in such circumstances, and I measured it from hand to hand when thumbs and fingers grasped the terminals of a wire and found it to vary between 6,000 and 15,000 ohms, and wrote to him to that effect, and from that grew out the statement to which you have referred. Now *under such conditions* that work is right, as I have frequently since proved.

"It seems to me that when we speak of the resistance of the body or of any body, and do not define what is meant by body, it is fair to assume that the body is the ordinary body under ordinary conditions. If the resistance (the *actual*) of the wire is found to be a thousand ohms by one party, and another one files off the rust from the contacts and then finds the resistance less, both parties may be right. Now, the skin of individuals is more or less horny in texture, and so has high resistance which soaking may reduce, and the question then properly arises, is the hard skin properly a part of the body? The resistance of a farmer's hand is often twice as great as that of a child's or of a man of sedentary habits, but solely, as I think, because of the thickness and density of his skin. Does not the question resolve itself into this—What is the resistance of a dry hand and the resistance of a soaked hand? What is the resistance of a good conductor and the resistance of a poor conductor? If the poor one is made better in any way, its resistance is correspondingly increased.

"If the condition of the body is abnormal, its resistance may also be abnormal. I should call a soaked skin abnormal.

"Still it is of the utmost importance that we should know what the resistance is under all conditions, as being the only way to advance in knowledge of the physiological effects of known currents, and I would again express my gratification at your persistent work in this field, and if I can in any way be of service to you I shall be pleased to be employed.

"To Dr. W. H. Stone. "A. E. DOLBEAR."

Query.—Can any of our readers inform us of any firm which undertakes the silvering of incandescence lamp globes.

NEW COMPANY REGISTERED.

British Inventors & Patentees Association, Limited.—Capital £10,000, in £1 shares. Objects: To afford inventors facilities for perfecting, developing, protecting, and carrying out their inventions and patent rights. Signatories (with one share each)—W. H. Fleming, electrical engineer; J. Robinson, locomotive superintendent; J. Hanson, G. H. Sharpe, analytical chemist; E. Topping, and T. Harrold; all of Liverpool. The first directors, who will be appointed at the first ordinary meeting, are to include, if possible, a mechanical engineer, an electrical engineer, a chemist, and a textile manufacturer or worker; directing qualification, 10 fully-paid shares. Registered 15th inst., by Messrs. Jaques, Layton & Jaques, 8, Ely Place, E.C.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Electrical Power Storage Company, Limited.—The annual return of this company, made up to the 7th inst., was filed on the 17th. The nominal capital is £800,000 in shares of £2 each, and the issued capital £600,000 in 300,000 shares of £2 each. The number of shares taken up is 264,900, or 27,100 less than the number recorded as taken up in the last return. Upon 50,000 shares £2 per share has been called, the remaining 214,900 shares being considered as fully paid. The calls paid amount to £100,000. The diminution in the number of shares is accounted for by the surrender of fully-paid shares previously allotted.

Oriental Telephone Company, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 17th inst. The nominal capital is £300,000 in £1 shares. 297,990 shares have been allotted. Upon 222,000 ordinary shares, 10s. per share has been called up and paid; upon 2,990 the full amount has been paid, and the remaining 75,000 (vendors' shares) are also fully paid.

Australasian Electric Light, Power, and Storage Company, Limited.—The annual return of this company, made up to the 28th January, was filed on the 13th inst. The nominal capital is £255,000 divided into 50,000 shares of £5 each, and 5,000 shares of £1 each. 31,000 shares have been allotted, and upon 24,000 of these £3 per share has been called, the remaining 7,000

being considered as having £5 per share paid thereon. The calls paid amount to £71,750, leaving £250 unpaid. Since the last return was filed, the paid-up capital has increased by the sum of £36,504 9s. 8d., chiefly due to the issue of the 7,000 paid-up shares. Registered office, 41, Coleman Street.

Metropolitan Brush Electric Light and Power Company, Limited (in Liquidation).—The liquidators of this company have signified to the Registrar of Joint Stock that the office of the company is now situate at 2, Walbrook.

DISSOLUTION OF PARTNERSHIP.

Pike, Oliver Osbaldeston, and **Sanderson, William Alexander,** electrical engineers, Virgil Street, City Road.

CITY NOTES, REPORTS, MEETINGS, &c.

London Platino-Brazilian Telegraph Company, Limited.

THE sixth ordinary general meeting of shareholders was held at the offices of the company, 66, Old Broad Street, on Thursday, Mr. John Pender, M.P., chairman, presiding.

The Secretary, Mr. William Payton, having read the notice convening the meeting, and the minutes of previous meetings having been confirmed,

The Chairman said shareholders were aware that the gentlemen sitting at that board some years ago rescued the company from being a total wreck. Since that time to the present they had been paying 2¾ per cent., and this, he might say, was paid upon an arrangement which, if the company had been carried through in a business-like way in the first instance, would not have cost more than half the amount of capital that was expended. The present board was not connected in any way with the management of the Western and Brazilian cable, upon the good or bad management of which depended their dividends; neither was the Western and Brazilian Company entirely dependent upon itself, their dividends more or less being influenced by the success of the Brazilian Submarine Company. One of the reasons why this company (the Platino) was paying a smaller dividend this half-year was that the Brazilian Submarine cable was interrupted for two months, and the result was that their proportion had been reduced by about £3,000, just about ¾ per cent. dividend on the capital; and this was a cause over which they had no possible control. But the bright feature in the case was that the Brazilian Submarine Company was about to duplicate its cable, and he had found in his experience in connection with submarine cables that unless a system was duplicated they could never trust to a steady and continuous income. With regard to the Government debt (about £7,360) they were endeavouring to obtain it, and were hopeful of doing so before the end of this year. He did not think the Brazilian Government had acted fairly towards the submarine telegraph companies. The Emperor himself said if they carried their systems to the Brazils they should have every help from the Government, and, although they could give no subsidies, they should have fair play, and the luxury of a monopoly. Instead of that, the Government had started land lines to compete with the submarine system, and the result was a considerable lowering in the prices in order to compete with a Government with a long purse. This was a great injustice, and he hoped the Western and Brazilian Company, which was constantly keeping the question before the Government, would be successful in its endeavours to alter the state of things. At the last meeting the issuing of the 6 per cent. debentures was discussed; he was pleased to say that they had succeeded in issuing those debentures at 6 per cent. instead of 7 per cent., and he thought the price was very fair. A difference had arisen with the Western and Brazilian Company as to the proportion of the gross revenue of the latter which this company was entitled to receive; but there were men of business on both boards, and he had every hope of an amicable settlement, but knowing their position to be so strong they were not likely to make any concession that would be injurious to the interests of the shareholders. He then moved the adoption of the report and accounts, and the declaration of a dividend of 2s. per share free of income-tax.

Mr. Hollocombe seconded.

Mr. Baker said he criticised the conduct of the board in issuing the debentures at the last meeting, but they had been so successful that he felt great pleasure in withdrawing any adverse remarks he made.

The motion was then put and carried unanimously.

Mr. John Hollocombe was re-elected to the board, and the auditors, Messrs. Deloitte, Dever, Griffiths and Company, were re-appointed, after which a vote of thanks to the chairman and directors brought the meeting to a close.

West India and Panama Telegraph Company, Limited.

AN ordinary general meeting of this company was held at the City Terminus Hotel on Wednesday, Mr. C. W. Earle, Chairman, presiding.

The Secretary, Mr. R. T. Brown, having read the notice convening the meeting,

The Chairman said the report, as usual with them, divided itself into three parts—the financial, the engineering, and what he might call the diplomatic, which last term meant their relations with the 15 different colonies and the three home governments; and a very heavy task of diplomacy it was. As far as the revenue was concerned, there was a slight increase in the traffic of £4,174 18s. 1d., for which he could give no special reason; probably it was owing to a better condition of the sugar trade during the half-year. Upon the expenditure a saving of £6,693 had been effected, to a small extent owing to reductions in the current expenditure; but the bulk was in connection with the expenses of their ship, the *Grappler*, and was in a great measure accidental. The *Grappler* came home to be repaired, and was employed in taking out new cable; the expense of that freight went to the credit of the ship, and to the charge against the cable when it was used. The expenses of the ship were therefore less than if it had remained stationary in the West Indies. The cost of the repair of the Jamaica-Porto Rico cable would be charged to the reserve fund, being practically a renewal. The *Grappler* was put into thorough repair in every respect for the sum of £866, a very moderate amount, the smallness of which was due to Mr. Holmes, who superintended the repairs. With reference to the reserve account, of which, on the 31st December last, £55,255 11s. 6d. had been invested in good securities, an additional £26,000 had since been put into similar securities. It was satisfactory to know that those investments were made prior to the recent rise in those securities in consequence of the expression of the views of the Chancellor of the Exchequer with regard to consols. The repair of the San Juan cable promised to be more expensive than they anticipated. The last time he met the shareholders the ship was just about to start to repair that cable. In the meantime, they had repaired the cable nearest to Porto Rico. After laying about 120 miles to the westward, they found the cable so decayed that in picking it up it broke seven times before they got it to the top. That proved the necessity of renewing that cable. Whilst engaged in these operations, the Colon-Jamaica cable failed, and they had to recall the ship and send her to repair the latter, since which time she had not been able to return to the San Juan cable. At that moment the two cables belonging to the International Ocean Company were both interrupted, and the *Grappler* was chartered to repair them; this would give them some little profit for the current half-year, and compensate to some extent for the falling off in the West Indian trade. Now they came to the question of the subsidies, the West India Commission report and their relations with the Government. The present position was pretty clearly laid before them in the report. They had the consent of all the colonies, with the exception of Barbados, to an increase of the subsidies. Barbados had always been particularly opposed to the company, and this was perhaps owing to the fact that the Press of the Islands was constantly writing against them, with the view of getting them to send more news; the papers desired to have long columns of news telegraphed to them for nothing. Sometimes the charges against them were rather grotesque; as, for instance, they were called to account in December for not having telegraphed the Queen's Speech. With regard to the report of the Royal Commissioners, he was in hopes that something more favourable towards them would have come from their investigations. The remarks made in the preamble of the report were all decidedly favourable, but in the summary their recommendation for an increase was made dependent on their constructing 2,000 miles of cable through the deepest water in the world, in order to carry the insignificant traffic of the West Indies, and also, the reduction of the tariff over their own lines. This recommendation really meant if they would cut their own throats, the Government would see if it could not help them. Reducing the tariff was quite impossible, experience having shown that the revenue was not raised thereby. No merchant in the West Indies telegraphed unless he was absolutely obliged to do so, and if they telegraphed almost for nothing between their system and Halifax, he did not believe the intercolonial traffic over their lines would increase to any appreciable extent. They would prepare a reply to Lord Derby upon this subject. It was most remarkable that such a large interest as theirs should not have been consulted during the investigations, whilst every petty question of rats, and every subsidy with respect to ice, was entered into. He then moved the adoption of the report and accounts, and the payment of 6s. per share on account of the arrears of dividend on the first preference shares.

Mr. Weaver seconded.

Mr. Griffiths said it was satisfactory to find that some of the West Indian colonies had a sense of obligation and honour, and that only one persisted in doing what was so despicable and contemptible. It was incumbent upon them, the shareholders, to try and move public opinion upon the subject in every manner they could. It was more serious to find that the report issued by the Government altogether ignored the principles of common justice. They had not been heard on the question, and it was unjust, therefore, that they should be saddled with those suggested enterprises. Who was to raise the capital for the new company? How were two cables to succeed where one could not? The sugges-

tions were outrages on common sense and common justice, and he trusted the shareholders would support the directors in resisting an undertaking so injurious, dishonourable, and altogether prejudicial to their best interests.

Mr. Veares, in the course of a somewhat lengthy and melodramatic, withal amusing speech, in which he distinctly averred his appreciation of the good services of the directors, suggested that instead of so large a sum being reserved, some portion should go to pay off the existing debentures.

A Shareholder asked, were they obliged to supply Barbados with news? Could they not cut Barbados off altogether?

The Chairman: We should then have all the other islands stopping their subsidies. With regard to Mr. Veares' suggestion, to pay off debentures with the reserve fund would not be safe; the reserve was for the purpose of meeting any renewals or other requirements with regard to the cable that might be necessary in order to keep going, and if they put it in debentures they would be in a difficulty if they should suddenly want £50,000 or £60,000.

The motion was then put to the meeting and carried unanimously, after which Sir James Anderson and Mr. Wm. Andrews were re-elected directors, and Mr. J. Griffiths auditor.

Votes of thanks to the Chairman, and the other directors, terminated the proceedings.

Lancashire Maxim-Weston Electric Company, Limited.

AN extraordinary general meeting of the shareholders of this company, convened by the liquidators, Messrs. Whitworth and Brown, was held at the City Terminus Hotel, Cannon Street, on Friday. Mr. Whitworth presided.

Mr. Reeves, solicitor to the company, stated that the liquidators had found it necessary to ask the attendance of shareholders for the purpose of placing before them a proposal made by the Maxim-Weston Company for the purchase of the assets of this company. The proposal was one which the liquidators, without their authority and sanction, could not deal with; but in their opinion it was very desirable that this proposal should be carried through, becauses the principal assets of the Lancashire Company consisted of plant and machinery, which were useful only for the purpose of electric lighting under the patents possessed by the Maxim-Weston Company. It was, therefore, very difficult, if not impossible, to find any person who would purchase such assets at a reasonable price. The consideration was that the Maxim-Weston Company should pay all the debts and liabilities of the Lancashire Company, and give the shareholders of the latter one share in the Maxim-Weston Company for every share fully paid up in the Lancashire Company.

The Chairman said they had called the shareholders together after having carefully considered the question of practical amalgamation with the parent company, and without hesitation both Mr. Brown and he believed that it was not only the best but the only course they could pursue. They had made overtures, unofficially certainly, to various persons they thought likely to buy the assets, but had received no real response, and the only course open, if this offer, which he thought a very fair and liberal one, was not accepted, was to sell the plant at the best possible price obtainable, which meant at a great sacrifice. He very strongly recommended the shareholders to accept the proposal of the parent company, and he hoped it would be effected unanimously.

Admiral Sir Edward Inglefield said he should like, as a late director of the company, to say a few words with reference to its position, and would ask the liquidators what had been done with reference to the trial of claims they had against two gentlemen who were largely indebted to the Lancashire Company. The present position of the company was entirely attributable to the failure of those gentlemen to pay the calls which had been made upon them.

A Shareholder asked what would be the position of the company after getting in the debts of Messrs. Gadsden and Harding, the shareholders referred to by Admiral Inglefield; and he would also like to know if the liquidators had gone into the business of the parent company, so as to satisfy themselves that they were recommending shareholders to join a thoroughly good and solvent concern.

The Chairman stated that the law-suit was still progressing; overtures had, he believed, been made with a view to a compromise, but nothing definite was yet settled. In the event of the transfer the responsibility for carrying on the cases was at once thrown upon the parent company. With regard to the position of the Lancashire Company, he begged to differ from Admiral Inglefield. They might, had Messrs. Gadsden and Harding's calls been paid, have gone on for some time; but the company had suffered from the first from an utter inadequacy of capital, and they could not possibly have gone on, even upon the limited scale they were then working. With the discredit thrown upon electric lighting generally, it was not very likely that the public would put any fresh money in the company.

Admiral Inglefield repeated that at a recent meeting this company was stated to be "a going business of high repute."

Mr. Campbell asked whether any portion of the claims against Messrs. Gadsden and Harding was at all shaky, as, it had been stated, a compromise had been under consideration.

Mr. Reeves said in the claim against Mr. Gadsden, so far as it was possible to judge of the result of a case, he thought the company must be successful; and, supposing Mr. Gadsden should be able to pay, they would recover from him about £2,000. With regard to Mr. Harding, the case presented two questions, and upon one he thought it was extremely doubtful whether the company could be successful; it might involve a great deal of litigation and discussion, and the result was exceedingly doubtful. With regard to the first part of the claim upon the shares which Mr. Harding clearly took, as a shareholder, there could be very little doubt that it would be favourable to the company, who would recover about £1,200.

Mr. Hugh Watt remarked that there was a counter-claim by Mr. Harding of £600.

Admiral Inglefield said he knew what that counter-claim was, and it was a very questionable one.

Mr. Campbell desired to know something of the position of the Maxim-Weston Company. Last year a report was made that the company was in a flourishing condition, but it was found that the actual state of things did not at all warrant the assertions made; and now, a balance-sheet and report had been issued, the first of which was altogether impossible to understand; the latter contained statements of a similar kind to those in last year's report, which, in the absence of any explanation, they were bound to view, remembering last year, with suspicion. One of the liquidators was a director of the parent company, and he would like to hear what he had to say.

Mr. Brown said at the time the report referred to was issued last year he was not a director, and when he joined the board he must say he thought the company was in an almost hopeless condition.

A Shareholder: Who was the chairman at that time?

Admiral Inglefield: I was. But without my knowledge that report was prepared and read. It took me completely by surprise. We had been making a loss of £230 per week, but at the time of the annual general meeting, at which I was the chairman, it was stated that we had made a profit of £200 a week.

Mr. Watt: For how long?

Admiral Inglefield: The managing director at that time (Mr. Hugh Watt), who is also managing director now, was responsible for those statements, and I must say that I did not believe in them.

Mr. Campbell remarked that the managing director, who was responsible for the illusory report last year, had again brought forward a statement showing his company to be in a favourable position.

Mr. Watt: The statements were accurate. For the month or two previous to the meeting at which the report was made, the accountant found that large sums were owing—there was a large deficit, and that went to carry on the company until the end of 1883. Those profits were absorbed in the working expenses to carry out the adventurous experiments entered into by that gentleman there (Admiral Inglefield).

Admiral Inglefield: I, sir, I! Why you were managing director for some time ——

The Chairman, interrupting, said he thought they had gone quite far enough into the affairs of the Maxim-Weston Company.

Mr. Brown said the questions put to him with reference to the position of the Maxim-Weston Company were quite irregular, and he must decline to answer them.

Mr. Campbell wished to know if it was not better to sell the plant for what it would realise, even if that were only 1s. in the pound, than to hand it over to Mr. Watt, to enable him to go on a little longer, and then to lose every halfpenny. Last year's report of the Maxim-Weston Company he believed to be absolutely inaccurate.

Admiral Inglefield said he wished to state that he was by no means antagonistic to the proposal before the meeting. All he wanted was, that the shareholders should be perfectly satisfied with what they were doing, and that they received a fair remuneration for their business.

Mr. Watt asked, in the event of the plant and entire assets being sold for what it would fetch, would enough be realised to pay the debts of the company.

The Chairman: If we sold it as a going concern, yes; but I doubt if that is possible.

Mr. Thompson, late manager of the Lancashire Company, spoke of the success which the company had met with at Liverpool, and said he had no doubt that, could they continue there, they would make a very handsome profit. They had been very successful, too, in lighting ships. Honestly and truly, he thought theirs (the Lancashire Company) was the only true and legitimate company in existence, the only one to demonstrate that electric lighting could be done properly. If they could have got the money owing by Messrs. Gadsden and Harding the company could have gone on.

The Chairman said it seemed to him that the course proposed was the only one from which they could expect any return. When they asked what was the value of the shares of the Maxim-Weston Company, he would tell them to go to the market; he was told those shares were readily saleable at 4s. or 5s.

Mr. Campbell observed that this was the most satisfactory statement that had yet been made.

Admiral Inglefield stated that the late chairman of the Lancashire Company was quite favourable to the amalgamation. He himself had no doubt that the liquidators, one of whom was a director of the company and one of the largest shareholders, had made full enquiries with respect to the parent company, and he thought they must consider fairly the course recommended by them.

The Chairman said he was very glad the matter had been discussed, as he did not wish them to hurry into any course. He wanted them to see facts and face them, as they, the liquidators, had had to do.

Admiral Inglefield suggested that Mr. Whitworth, as a director

of the Lancashire Company, should have a seat on the board of the Maxim-Weston Company to watch after the interests of the shareholders in the former.

The Chairman observed that he would rather not, and

Mr. Hugh Watt said Mr. Whitworth had consented to co-operate with them as agent, which would probably be the most convenient course. The matter then dropped.

The Chairman moved, "That in the opinion of this meeting it is desirable that the proposal of the Maxim-Weston Company should be accepted, and that the liquidators be requested to take the necessary steps to carry out the same."

Admiral Inglefield seconded the resolution, which was carried unanimously.

Mr. Campbell moved a vote of thanks to the liquidators, which was carried, terminating the proceedings.

Maxim-Weston Electric Company, Limited.

AN extraordinary general meeting of this company was held at the City Terminus Hotel on Friday, for the purpose of confirming resolutions passed at a previous general meeting. Mr. Hugh Watt, managing director, presided.

The notice convening the meeting having been read, the chairman moved the confirmation of the following resolutions:—

"That the capital of the company be reduced by £100,000, by cancelling paid-up capital which has been lost, or is unrepresented by available assets to the extent of 10s. per share upon each of the 200,000 shares which have been issued and are now outstanding."

"And that the capital of the company be further reduced by £150,000, by reducing the nominal amount of all the shares in the company's capital from £1 to 10s. each, thereby leaving the nominal capital of the company £250,000, divided into 500,000 shares of 10s. each."

"That no further issue of shares in the company beyond 50,000, making with the 200,000 shares already issued 250,000 shares, be made without the sanction of a resolution of the shareholders passed at a general meeting of the company to be duly convened for the purpose."

In moving these resolutions, the chairman pointed out the reasons for reducing the capital, and explained various items in the balance-sheet for the benefit of those who were not present at the previous meeting. The present directors considered that the sum at which the patents appeared in their books was greatly in excess of their actual value, and they had resolved to bring it down to a more reasonable sum and had reduced it from £120,000 to £70,000. He then spoke very highly of a new lamp, the invention of Professor Weston, which had the characteristics of the old Maxim-Weston lamp—durability and steadiness. The new shares issued had nearly all been subscribed by the present board and their friends. Profits had been derived from sales of dynamos, &c., and they had done no other business except out and out sales, except that which had been distinctly profitable. Personally, he believed they would be in a position during the coming year to pay a dividend, but that would not be done out of stock, of which they had not too much.

The resolutions having been seconded and carried,

The Chairman said the Lancashire Company had been re-absorbed, and they would now gain command of important districts in which they hoped to work on a remunerative scale. The Corporation of Liverpool were considering the question of continuing the lighting of the town under their system, and there was a probability of the decision being favourable to the company. Having mentioned several large installations which had been carried out by the company or for which they were treating, the chairman stated that he considered Professor Weston the first practical electrician of the day, and his new lamps were perfect marvels, much better than any other incandescent lamps.

A vote of thanks to the chairman and the directors brought the meeting to a close.

The Consolidated Telephone Construction and Maintenance Company, Limited.

THE following report is to be presented at the third general meeting of this company on Friday, the 23rd inst:—

It will be seen by the revenue account that the amount standing to the credit of profit and loss account, including the amount carried forward from last year, is £10,290 17s. 9d. The directors feel that it would be unwise to recommend a dividend at present, having regard to the position of the company's interests in Austria, in connection with which, as was explained at the last annual meeting, the company had come under obligations involving a very heavy capital expenditure. The condition of the money market during the past year has not rendered it practicable to place those interests on a separate footing in the sense indicated in the last report. Since then the deputy-chairman, through a personal visit to Vienna, has succeeded in effecting a very important compromise with the vendors, by which the position of the company has in several respects been considerably improved. There remain, however, contingent liabilities to a considerable amount.

From the balance to the credit of profit and loss, viz., £10,290 17s. 9d., it is proposed by the directors to write off the whole of the discounts and expenses incurred in connection with the further issue of capital, viz., £5,685 12s. 6d., and in reduction of plant and machinery account, £2,068 10s. 3d., making a total of £7,754 2s. 9d., thereby leaving a balance of £2,536 15s. to be carried forward.

While these results are far from satisfactory, it can be clearly shown that they are chiefly, if not entirely, due to causes beyond the control of the board.

As is well known, at least to the original shareholders, the principal reason for the formation of the company, and its mainstay for business, was the contract with Her Majesty's Postmaster-General. For a considerable time the profits from this source alone represented a substantial dividend upon the whole of the issued capital, besides giving promise of a long continuance. The business under this head, however, has dwindled away to almost nothing, the transactions in the past year amounting only to £886 0s. 7d. gross, and these, moreover, of such a class as to allow of very little profit.

The directors are happy to be able to state that the difficulties which were referred to in the last report, as having arisen between the United Company and this company, then in course of arrangement, have since been completely settled to the satisfaction of both parties, and in such a manner as to justify the belief that there is no danger of their recurrence. The transactions with that company, however, have fallen very far short of being so large as the directors were originally justified in expecting they would be. This may be accounted for chiefly, if not entirely, by the restrictions placed by the Government upon the United Company and its affiliated companies, by which the exchanges are, with very few exceptions, confined within the limits of a five mile radius. When these restrictions are removed, as it would seem they must be, sooner or later, if public convenience is to be consulted, there will inevitably be an enormous development of the telephone in this country, something at least commensurate with that which has already taken place in other countries where this class of enterprise is not similarly hampered; and as all the telephones for use in the United Kingdom (under Edison's, Bell's, and other patents of the United Company and those of this company) must be obtained from this company, it follows that when the above restrictions are removed, the business of manufacturing telephones will become very large.

The great depression during the past year in electrical enterprises generally has resulted in necessarily limiting the manufacturing branch of the company's business to the telephone and its direct accessories.

In the not unreasonable anticipation of a large manufacturing business, at the time of selecting premises for the purpose, much larger accommodation was provided than events have since proved to be necessary, thereby incurring a considerable expense, which the board would now be glad to see diminished; and unless something is shortly done to meet the well-known demands of the public for less restricted telephonic communication, the board will be obliged to take into consideration either a change to less expensive premises, or the sub-letting of a portion of those now occupied.

The expectations previously expressed by the board as to the probable value of the company's interests in the River Plate Telephone Company have been realised, as may be seen by the report of that company.

The company's interests in the Edison Gower-Bell Telephone Company of Europe, Limited, are principally represented by the exchanges in Lisbon and Oporto, which have steadily progressed during the past year. No report of that company has been published, it having been found impossible to make up the accounts until the concession under which the business is operated shall have been more fully interpreted.

In connection with the settlement of the River Plate account, a question as to the powers of the board has been raised. An extraordinary general meeting has therefore been summoned, and will be held immediately after the general meeting, to confirm the action of the board.

The "Pilsen," "Joel," and General Electric Light Company, Limited and Reduced.—The following circular has been issued to the shareholders of this company:—"The directors have this day (May 15th, 1884) made a call of 15s. per share on the partly paid-up shares of this company. Of the amount realised by this call, a sum equal to 10s. per share, or thereabouts, will be used for the purposes authorised by the special resolutions passed on the 6th and confirmed on the 21st March last, and the residue for the general purposes of the company. The necessity for calling up more than the sum required for the purposes of the special resolutions is caused by the expenditure recently incurred in the installations at the Bethnal Green Museum and the International Health Exhibition, the rentals from which form a satisfactory source of profit to the company."

The Liverpool Electric Supply Company, Limited.—The directors of this company have, out of the profits of the past year, paid a dividend at the rate of 5 per cent. per annum, and have carried forward a similar amount to the current year's account.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 16th, 1884, were £2,751, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th May, are £2,000 as compared with £3,568 in the corresponding period of 1883.

PROCEEDINGS OF SOCIETIES.

Physical Society, May 10th, 1884.

THE meeting was held in the chemical theatre of the Mason College, Birmingham. Members had previously visited some of the factories in the town, including Gillott's pen works.

Dr. GUTHRIE, President, took the chair at 3 p.m., when

Prof. J. H. POYNTING made a communication on "An experiment illustrating the refraction of water waves." The experiment was designed to illustrate, by means of waves in water, the refraction of waves when they pass from one medium to another in which their velocity is different. The apparatus consisted of a tank 2 ft. 6 in. square, with a plate-glass bottom. Water is poured into the tank to a depth of say 5 to 6 millimetres. The lid of the tank consists of a calico screen, and is slightly tilted up. A lime light under the tank projects the wave on a screen. Plates of glass, 3 or 4 millimetres thick, are placed in the tank, thus reducing the depth of water. If waves are sent across the tank they travel more slowly through the shallow water, and are seen to be refracted. When circular or centicular plates are used, the refracted waves are seen to converge to a focus.

Mr. C. J. WOODWARD exhibited an oxy-hydrogen lantern, suitable for lecture purposes.

Dr. GLADSTONE took the Chair, and

Prof. GUTHRIE, President, exhibited a sealed tube containing 46·6 of tri-ethylamine and 53·4 of water. At temperatures between 0° C. and 18·3° C. the liquid forms a clear mixture. At 18·3° it becomes turbid, and at 26° C. almost perfect separation is effected. It was stated that all proportions of the two liquids containing about 15 per cent. and 50 per cent. of tri-ethylamine become turbid at the same temperature. A mixture containing 4 per cent. requires a temperature of 41° C. to produce turbidity, while one containing 90 per cent. is turbid at 6° C. A series of sealed glass bulbs, containing the liquids in different proportions, can be employed to indicate the fever temperature of the body if placed under the tongue. The author also showed the connection between such separation by heat and the separation between the same two bodies by cold, whereby in the latter case, according to the strength of the solution, either ice or subcryohydrate is separated until the composition and temperature of the cryohydrate is reached (19·2 per cent.; − 3·8° C.). The peculiar white condensed vapour of the chloride of triethylamonium was exhibited. The white fume of this body so quickly aggregates into masses, that the shapes of the smoke lines and curls are preserved.

Dr. GLADSTONE agreed with the author in supposing that the separation of triethylamine and water was continuous in nature with the separation of ammonia from water by heat.

Dr. TILDEN exhibited a tube containing a cold clear solution of amylic alcohol in water, which became turbid on gently warming, and clear again on heating to about 60° C. He suggested that a similar remixing might take place with ethylamine and water.

Prof. SILVANUS P. THOMPSON recalled the experiments of Prof. Ramsay on the critical state described by Andrews, and the failure of a body beyond the critical condition to retain in solution the substances it held as a liquid.

Mr. W. LANT CARPENTER suggested the microscopic examination of the tri-ethylamine and water mixture at its critical temperature.

Members then visited the college rooms.

NEW PATENTS—1884.

7699. "Automatic electrical current regulation." J. GILMORE, W. R. CLARK. Dated May 14.

7717. "Telephone transmitters." W. R. LAKE. (Communicated by J. A. Kingsbury.) Dated May 14.

7773. "Electric signal apparatus for fire alarms, telephone calls, &c." H. A. C. SAUNDERS, A. C. BROWN. Dated May 15. (*Complete*).

7805. "Machines for generating or utilising electrical energy." G. G. M. HARDINGHAM. (Communicated by C. Mortimer-Sterling.) Dated May 16.

7829. "Galvanic element." A. M. CLARK. (Communicated by Wirth & Co. [A. Dun].) Dated May 16.

7833. "Electrical apparatus for telephonic purposes." J. W. BROWN. Dated May 16.

7853. "Retouching or remodelling photographic negatives by aid of electricity." G. BROWN. Dated May 17.

7925. "Electric wires or conductors for telephonic or telegraphic communication." A. F. ST. GEORGE. Dated May 19.

7926. "Receiving and recording vibrations produced by sounds and reproducing same." A. F. ST. GEORGE. Dated May 19.

7962. "Electric arc lamps." P. M. JUSTICE. (Communicated by S. H. Short.) Dated May 20.

7984. "Secondary or storage batteries or accumulators." T. S. SARNEY, W. R. BARRITT. Dated May 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

4416. "Apparatus for use in charging secondary batteries or accumulators." T. J. JONES and E. C. RIMINGTON. Dated Sept. 14. 2d. The object of the present invention is, by means of an electro-mechanical contrivance, when the current falls below a certain point prior to reversal, to automatically cut off the batteries from the dynamo and substitute for them a suitable resistance, through which the dynamo is circuited until it recovers sufficient electromotive force to again overcome the opposing electromotive force of the accumulators, and continue the charging when the current is again automatically switched on to the batteries, thus obviating any need of attention. This contrivance consists essentially of a balance beam in the circuit of the dynamo, in combination with an electro-magnet and mercury contacts arranged in such manner that when the beam is oscillated in one direction the circuit is made through the batteries, and when oscillated in the other direction this circuit is broken, and is made through the resistance, the electro-magnet being in the dynamo circuit, and causing the beam to assume the former position, as soon as there is sufficient current set up to excite the field magnets of the dynamo to such an extent as to give a sufficient electromotive force. The electro-magnet then becomes strong enough to oscillate the beam, which is adjustably weighted so as to automatically assume the latter position when the electro-magnet loses its power. The beam can be so adjusted as not to be oscillated until the desired current is obtained and the beam is provided with an adjustable bob for varying its sensibility as required. The surfaces of the mercury are so arranged that contact is made at the one before it is broken at the other, and the surfaces are covered with some (preferably non-oxidisable) fluid to prevent excessive sparkling. (*Provisional only.*)

4521. "Effecting ignition of electric candles." W. D. GOOCH. Dated Sept. 21. 2d. Has for its object improvements in means for effecting the ignition of electric candles in arc lamps, and which improvements are specially applicable for adaptation to "Jablochkoff" candles for bridging the two poles forming the candle, and at such time when no current is passing through them and serving to conduct the current for lighting the candles and establishing the voltaic arc. The inventor proposes to attach to the points of the carbons after partial use, or before being consumed at all, a small piece of carbonised fibre or fibrous material, either woven in the form of a flat or twisted cord. (*Provisional only.*)

4563. "Armatures for electric current generating machines." H. J. HADDAN. (Communicated from abroad by C. F. Brush, of America.) Dated Sept. 25. 6d. Relates to certain improvements in the construction of the revolving armatures of electric-current generating machines, and more particularly to those of the "Brush" system. The armature of the present invention is an improvement on the present "Brush" armatures, chiefly in the fact that the laterally projecting portions thereof, between which the wires are wound to form the bobbins, are formed or built up of a series of comparatively thin and distinct metallic plates, interposed between the coils or folds of a metallic ribbon, which, when coiled, forms either alone or in connection with an inner or base ring on which it is wound the annular portion of the armature.

4573. "Portable electric lamps, &c." R. BARLOW. Dated Sept. 25. 6d. Relates to a combination of devices whereby in any self-contained voltaic lamp the electrodes may be withdrawn altogether, or in part from the exciting fluid, without necessitating any considerable enlargement of the base or battery compartment of the lamp, and whereby an effectual electric contact may be maintained in the circuit between the lamp and the battery, when the former be caused to rotate in a horizontal plane.

4578. "Dynamo-electric machines." W. P. THOMPSON. (A communication from R. J. Sheehy, of America.) Dated September 25. 6d. First, for the purpose of generating currents economically, the machine is constructed with a number of field pole-pieces arranged in a series of alternating polarities, and provided with intermediate armatures between adjacent pole-pieces, and exterior armatures against the outer faces of exterior pole-pieces. Secondly, the fields of the several armatures are maintained by means of the currents generated in said outer armatures, employing one or both, as may be required. Thirdly, the driving power is communicated from a main shaft to the independent armature-shafts through the medium of friction gearings, which may be independently operated. Fourthly, mechanism is provided whereby the length of all of the conductors in each of the several bobbins of any armatures may be simultaneously increased or reduced to compensate for changes in the conditions of the external circuit; and, fifthly, means are provided for automatically operating said mechanism for varying the length of the conductors in the armature bobbins when the normal strength of current is disturbed, thereby so altering the electromotive force and internal resistance of said armature, as to restore the normal strength of current generated.

4585. "Galvanic batteries, &c." A. W. WARDEN. Dated September 26. 6d. The inventor provides for the constant flow of the exciting liquid or liquids from a reservoir or reservoirs directly to the several cells, and for the corresponding outflow of such exciting liquid or liquids, by which means he is enabled to prevent polarisation and the formation of deposits on the elec-

trodes and the cell bottoms. In constructing a single fluid battery, he arranges the electrodes in any well known or approved manner, and connects the cells at bottom and near the top, severally with pipes running longitudinally of the battery, such pipes being composed of ebonite, glass, or other suitable material, and leading the one to a reservoir and the other to a receiver. The reservoir will supply the several cells by gravitation, and the exciting liquid discharged he proposes to raise by pumping again to the reservoir.

4609. "Electric clocks." W. P. THOMPSON. (A communication from A. Winbauer, of Austria.) Dated Sept. 27. 2d. Relates to improvements in self-acting electric clocks, which differs from other electric clocks by the fact that for its regular winding up only a weak current (such as generated by one or two Leclanché elements) is required. Moreover, the circuit being closed a very brief time at every winding up of the clock, long duration of the battery is secured. The regular speed of the hour train is perfectly independent of variable strength of the electric current, the whole construction, when compared with that of other electric clocks, is very simple, and may be employed, with clocks of every system and size, whatever may be the length of the pendulum. (*Provisional only.*)

4619. "Apparatus for supporting electrical conductors, &c. J. SITZENSTATTER. Dated Sept. 28. 2d. The chief object of the invention is to provide an apparatus to be secured to the roofs of houses, or other structures, for supporting electrical wires or conductors, the said apparatus combining strength with lightness, and being capable of supporting the greatest possible number of wires within the smallest possible space, and being, moreover, of neat and ornamental appearance. (*Provisional only.*)

1884.

4060. "Improvements in printing telegraphs." W. P. THOMPSON. (Communicated from abroad by H. Van Hoevenbergh, of America.) Dated February 28. 6d. Relates to certain improvements in the construction of devices for determining from which particular one of two type-wheels in a printing telegraph receiving instrument an impression shall be taken. The object of the invention is to so organise the apparatus that the desired impressions may be taken from either of the type-wheels at a distant station by means of electric currents transmitted over a single main line conductor, without the aid of complicated mechanism. The invention consists in constructing an instrument with a double electro-magnet for controlling the movements of an escapement device and two additional independent electro-magnets which are respectively adapted to actuate a press lever, and to determine the position of a printing platen of peculiar construction. This platen is virtually a double one, consisting of two single platens united at an angle with each other and situated in different planes, the one being located in the plane of one of two parallel type-wheels, and the other platen in the plane of the other type-wheel. When the armature-lever, which is employed for determining the position of the double platen, is remote from the poles of its electro-magnet, one of the platen faces will be presented to the corresponding type-wheel, and, if the press-lever be then actuated, it will cause an impression to be taken from that type-wheel in the usual manner, the other platen face meantime remaining at such an angle with reference to its type-wheel that no impression will be taken therefrom. When on the contrary the armature is attracted to the poles of its magnet, the double platen will be turned, by means of suitable intervening mechanism, so that the second platen-face will be presented to its type-wheel, and the first platen will be at such an angle that no impression will be taken from the first type-wheel. It will appear from the foregoing description that it is necessary to provide currents of alternating polarity for actuating the escapement mechanism for controlling the rotation of the type-wheel and currents having a strength somewhat greater for actuating the press-lever, or, if preferred, the printing magnet may be constructed to respond to a prolonged current of the same strength as the alternating currents. In either event, the current employed for this purpose should not be of sufficient strength to actuate the armature of the platen-controlling magnet, but this armature is so constructed or adjusted that it will respond only to currents of increased strength, such currents being also adapted to actuate the press-lever. By means of currents of this class impressions may be taken from the second type-wheel. Fig. 1 is an elevation showing the organisation of the apparatus, and fig. 2 is a perspective view illustrating the construction of the platen. A 1 and A 2 represents two type-wheels of usual construction placed side-by-side upon a shaft, *a*, the periphery of the type-wheel A 1, for instance, being engraved with type representing numerals while that of the type-wheel A 2 is engraved with letters. Carried upon the shaft, *a*, is a scape-wheel, B, normally tending, through the stress of a spring or weight, to revolve continuously in the direction indicated by the arrow. An anchor-escapement, C, of ordinary construction regulates or controls the movements of the wheel, B, by engaging teeth alternately upon opposite sides of the same. The necessary vibrations of the escapement pallets are occasioned by an electro-magnet, M M 1, acting, under the influence of alternating electric currents traversing its coils, to impel a polarised armature, D, to and fro, in a manner well understood. The type-wheels are thus simultaneously caused to advance step-by-step and to successively present the individual type upon their peripheries to a combined or double printing platen, E. The double platen, E, consists of two single platens, *e* 1 and *e* 2, rigidly secured to each other and respectively designed to take impressions from the type-wheels, A 1 and A 2. The combined platen thus formed is pivotted in a bracket upon the armature-lever, F, of a press-lever, F¹. The two parts of the same are, however, united at an angle as best seen in fig. 2, so that while the printing face of one of the platens, *e* 2 for instance, is presented to its type-wheel A 2, the face of the other platen will be in such a position as not to come in contact with its type-wheel A 1, during the upward movement of the press-lever, F, and *vice versâ*. For the purpose of controlling the position of the double platen, E, a special electro-magnet, K, is provided. The armature-lever, H, of this magnet is coupled by means of a pivoted link, J, with an arm, *e* 3, upon the platen, E. When the armature-lever is away from the poles of its electro-magnet, K, the platen will be caused to assume the position shown in full lines in the drawing, with the part, *e* 2, facing the type-wheel A 2. When, however, a current of sufficient strength to attract its armature, *h*, to its poles, traverses the coils of the electro-magnet, K, the armature-lever and platen will be moved into the position shown in dotted lines, fig. 1, the part *e* 1 being in the position to cause

FIG. 1.

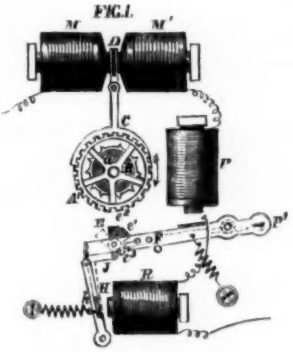


FIG. 2.

impressions to be taken from the other type-wheel, A¹. The printing magnet, P, may be constructed either to respond to currents of greater strength than those employed for actuating the escapement, C, or to a simple prolongation of one of the alternating pulsations, while the armature of the electro-magnet, K, will respond only to currents of a strength still greater than those required to actuate the press-lever. The latter, however, will also respond likewise to the strongest currents. It will thus be seen that when it is desired to print characters from the type-wheel A 2, the type-wheels should be revolved until the desired character is opposite the platen when a current of the character required to actuate the lever, F¹, should be transmitted through the coils of the magnet, P. If, however, an impression should be desired from the type-wheel A 1, after it has been arrested in the proper position, a current of the strength requisite to actuate the lever, H, of the electro-magnet, K, should be transmitted through its coils. The platen will be caused to assume its second position, and the press-lever will be actuated thereby. In order to insure the platen being in position to print from the type-wheel A 1, under the influence of a strong current, before the press-lever has carried the same into too close proximity to its type-wheel, it is preferred to so construct the electro-magnet, K, that it will acquire the full degree of magnetisation of which it is susceptible under the influence of a current of given strength, somewhat more quickly than will the electro-magnet, P. In this manner the armature-lever, H, may be caused to assume its forward position under the influence of a current of the strength required to actuate it, before the press-lever responds to the action of the same current.

CORRESPONDENCE.

The Gower-Bell Telephone.

I shall esteem it a great favour if you will, through your columns, furnish me with answers to the enclosed questions, which I believe have somewhat of a general interest.

Volta.

Southport, *May 14th*, 1884.

1. Who is the present holder of the patent for Gower-Bell telephones—the United Company or the Post Office?

2. Does the Post Office pay any royalty for the user of them?

3. How is it that railway companies can buy, but the general public may only hire Gower-Bell telephones?

4. Who manufactures the Gower-Bell telephones which are let out on hire by the Post-Office department?

[We believe that the Consolidated Telephone Company, under license from the United Telephone Company, is the present holder of the patent in question. The instruments used by the Post Office are purchased, and no further royalty paid. We think that the instruments employed by the railway companies are supplied to them by the Post Office, and that the latter has the right (which, however, we fancy is not exercised) to supply the general public. The instruments are manufactured, at least nominally so, by the Consolidated Company.—EDS. ELEC. REV.]

The Efficiency of Secondary Generators.

In your notice of the communications to *La Lumière Electrique* it appears that M. Deprez proposes to make comparative tests in "measuring the industrial return of any system of transformers whatever."

M. Deprez suggests that a hundred incandescent lamps should be supplied on the usual method by an alternating dynamo giving just sufficient current to bring the lamps to their normal candle power. The speed of the dynamo is to be taken, and an electro-dynamometer placed in the circuit.

M. Deprez then says: "Let us now place any *transformer whatever* in the circuit, and maintain the same speed of the machine. However perfect it may be, this transformer *evidently* will not supply the same number of lamps if we maintain the current which traverses them at the same value as before, and if we do not modify the speed, and consequently the number of alternations of the current. The number of lamps will therefore be less," &c.

It would seem by the above remarks that M. Deprez does not consider the action of the transformer of sufficient importance to explain *why* it "evidently will not supply the same number of lamps."

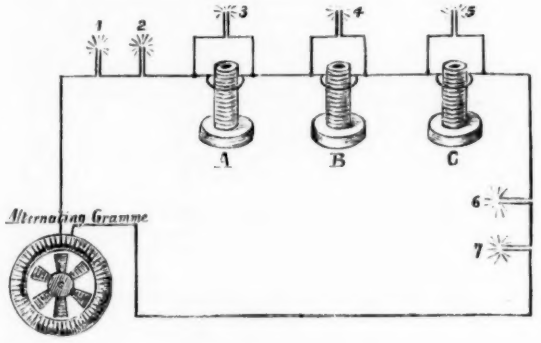
As to increasing the number of alternations experience proves that beyond a certain point such increase is detrimental by reason of iron being present in the transformers. For this reason however correct the tests might have been at the Metropolitan installation, they could have been no criterion as to the possible future efficiency of secondary generators for electrical distribution.

With your permission I will endeavour to show that under suitable conditions there is a marked advantage in generating and distributing electrical power by transformers—an advantage which may be proved in the way suggested by M. Deprez.

In your issue of Feb. 19th last, an article appeared on my motor induction machine; reference was also made to a system of electrical distribution by transformers, or induction coils. These latter consisted of an electro-magnet, or a battery of magnets having one main circuit, whilst the lamp, or consumption circuit, was joined to the main conductor on each side of the induction coil, and so forming a shunt enclosing the coil. It is unnecessary to say that there is no secondary circuit in this arrangement. Since the above article appeared I have had an opportunity of testing this system with results sufficient to give confidence in dilating upon it now. The accompanying diagram will probably make it clear, as it is extremely simple.

1, 2, 3, 4, &c., are Jablochkoff candles; A, B, C, are induction coils. Each coil is 10 inches long, with a resistance of half an ohm.

It will be seen that four candles, 1, 2, 6, and 7, are placed in the main circuit before and after the coils. In an installation proper, all the lamps would be placed in shunt circuits. I have, however, arranged them in the present case, as shown in the diagram, in order to emphasise a particular physical action that occurs in the induction coils, because the resistance *external* to each coil plays an important part in this system.



The main circuit is supplied by an alternating Gramme machine, giving from 6,000 to 7,000 alternations a minute.

As it is difficult to imagine what occurs in the coils when the alternations are so numerous, let us suppose there are only *six alternations* a minute; we shall then have time to study the action of one of the electrical waves transmitted. If we take the middle coil, B, with its candle, 4; as the electrical resistance of the former is half an ohm and the latter four ohms, it follows that eight-ninths of the initial current would pass through the coil and one-ninth through the candle. *But* there is a counter E.M.F. produced in the coil, and this would *tend* to transmit itself through the whole main circuit. To do that, however, it would have to overcome the sum of the resistances of candles 1, 2, 3, 5, 6 and 7 = 24 ohms. By referring to the drawing, it will be seen that it has a shorter route with a resistance of one candle only, so that six-sevenths of this back E.M.F. passes through the shunt circuit of the coil, B, and instead of being opposed and detrimental to the generator, it is transformed into heat and light.

E. L. Voice.

1, Francis Street, W.C.,
May 20th, 1884.

P.S.—If I had the means, I would speedily show in a most practical manner the great advantage of the above system of electrical distribution, but at present it seems useless to do anything electrical. Hitherto this country has been the pioneer in the development of new industries, and with what gigantic results! Things appear to have changed, however. The columns of the ELECTRICAL REVIEW and contemporary journals bear witness to the fact that other countries are far in advance in the application of this comparatively new science. At present we hear a great deal about the importance of technical education. How infinitely more important is it to be in advance in providing the very subject matter for the employment of this technical skill! Under certain conditions electricity is as much a natural force as a gale of wind or a waterfall, and to expect that it will always remain a mere medium for the transmission of power, would be about as reasonable as to compare the lightning flash and its terrific energy with the driving belt of a steam engine!

Telephone Patents.

Will Mr. Handford, or any of your readers, be good enough to answer this question?

Can any person supply parts of telephones, transmitters, and receivers, without being liable for infringement? It is said that large numbers of ebonite telephone cases are sold without question or hindrance. If this is true, why should not any one be able to sell the other parts?

F. Williams.

May 15th, 1884.